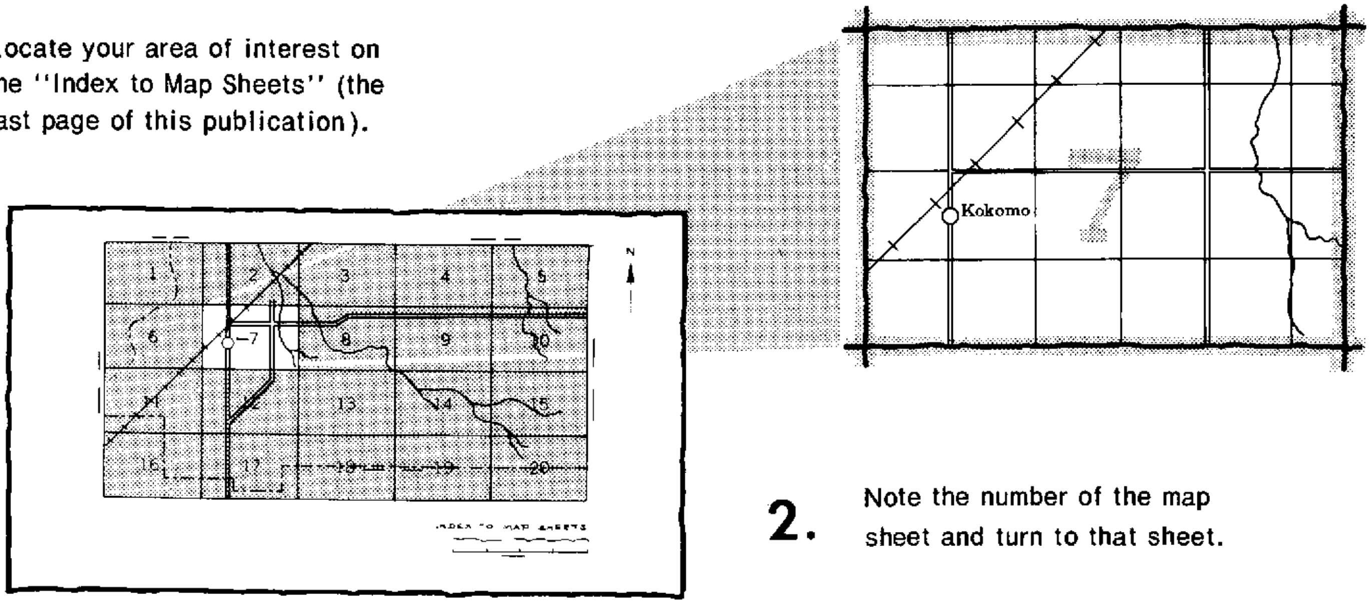
SOIL SURVEY OF
Hamilton County, Indiana

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Purdue University Agricultural Experiment Station

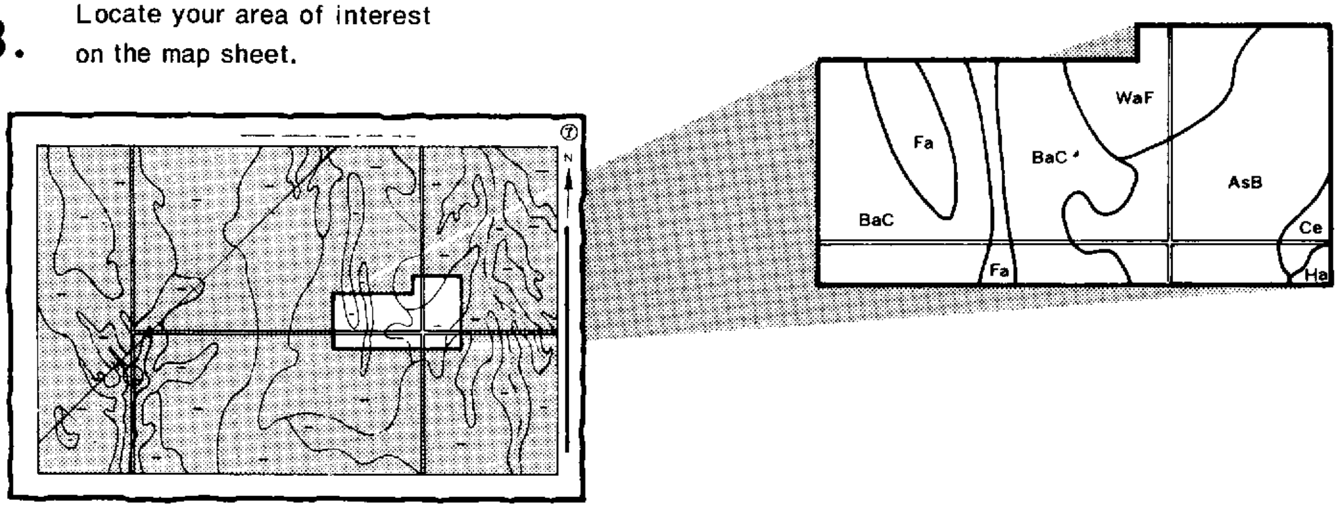
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

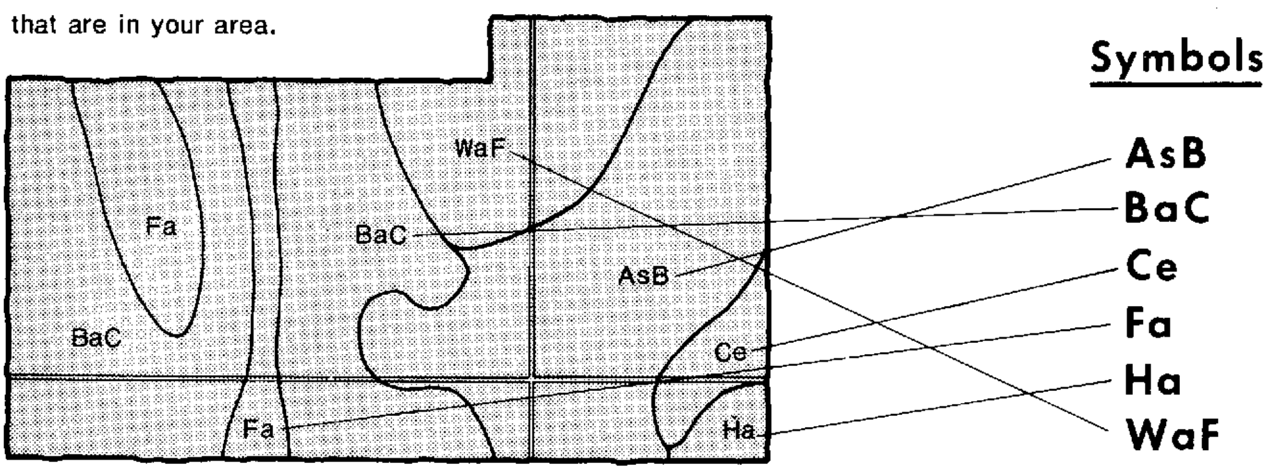


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.

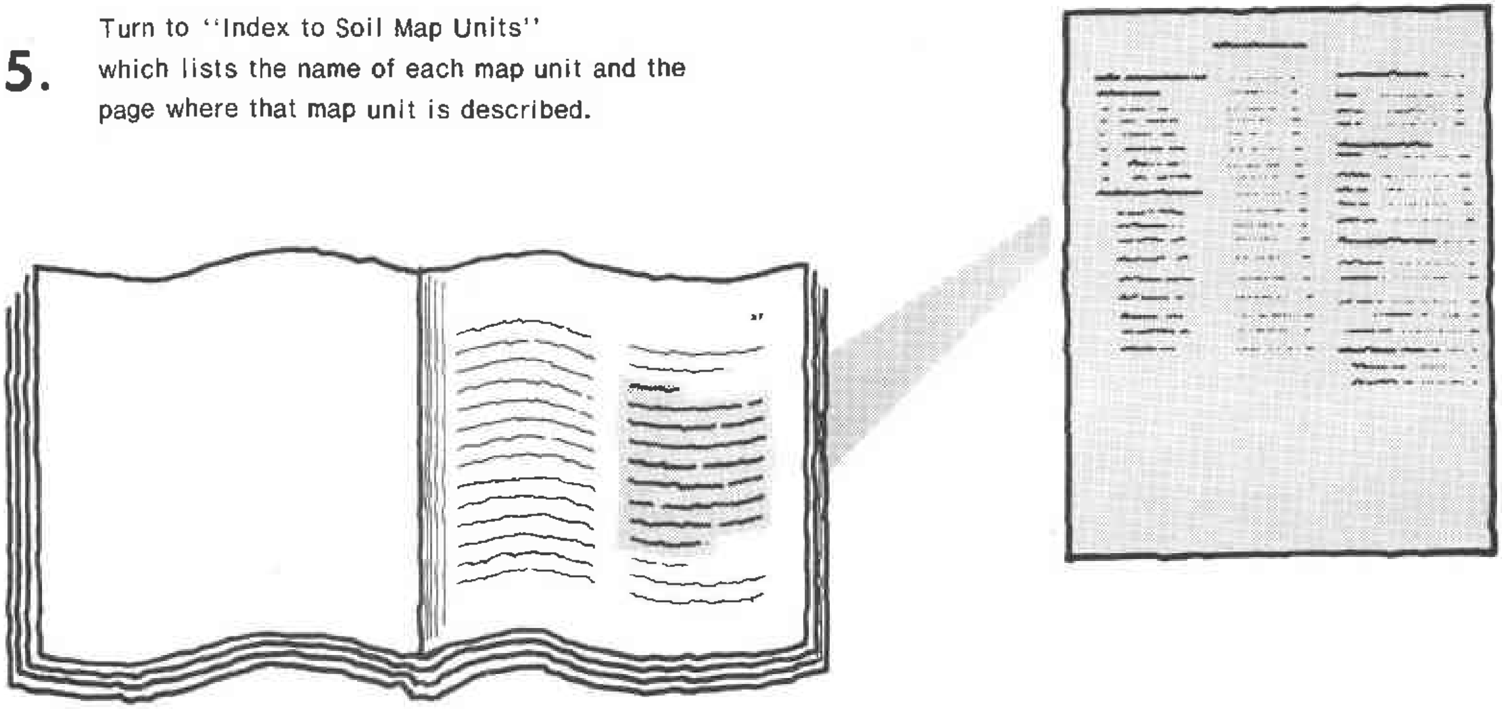


4. List the map unit symbols that are in your area.

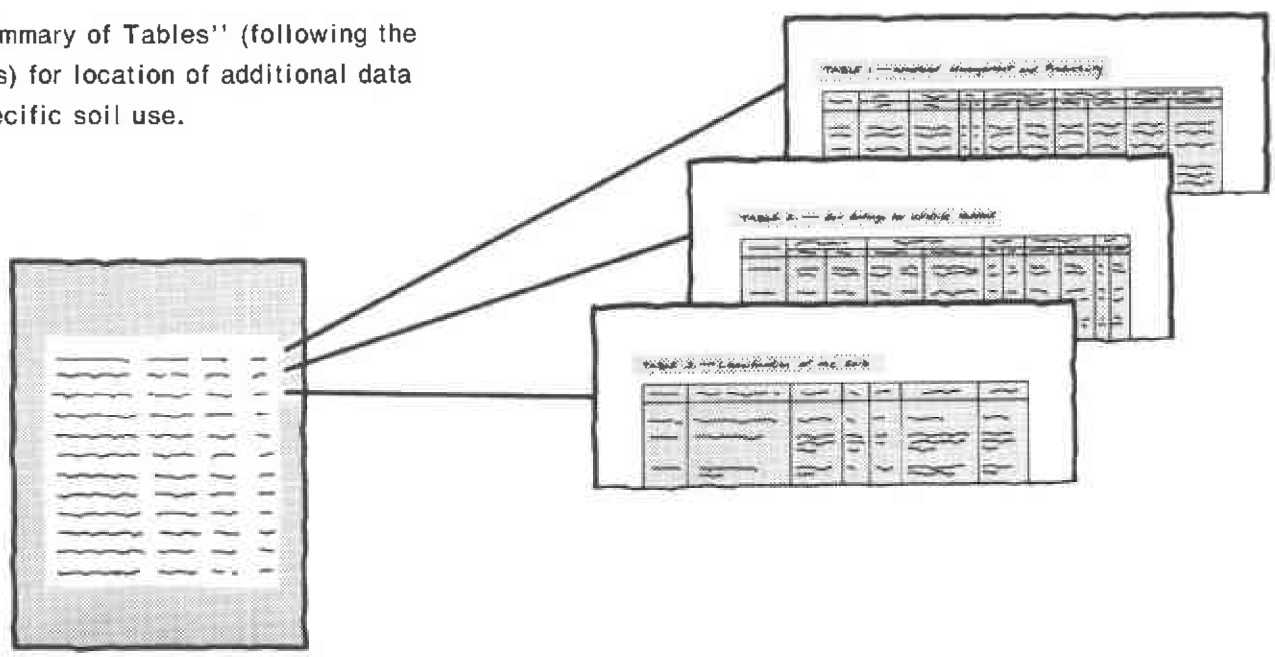


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1972-75. Soil names and descriptions were approved in March, 1976. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in March, 1976. This survey was made cooperatively by the Soil Conservation Service and the Purdue University Agricultural Experiment Station. It is part of the technical assistance furnished to the Hamilton County Soil and Water Conservation District. Some financial assistance was furnished by Hamilton County and the State of Indiana.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: This grassed waterway helps to prevent excessive soil losses from erosion in an area of Miami silt loam, 2 to 6 percent slopes, eroded.

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Issued November 1978

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Summary of Tables

Foreword

The Soil Survey of Hamilton County, Indiana contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

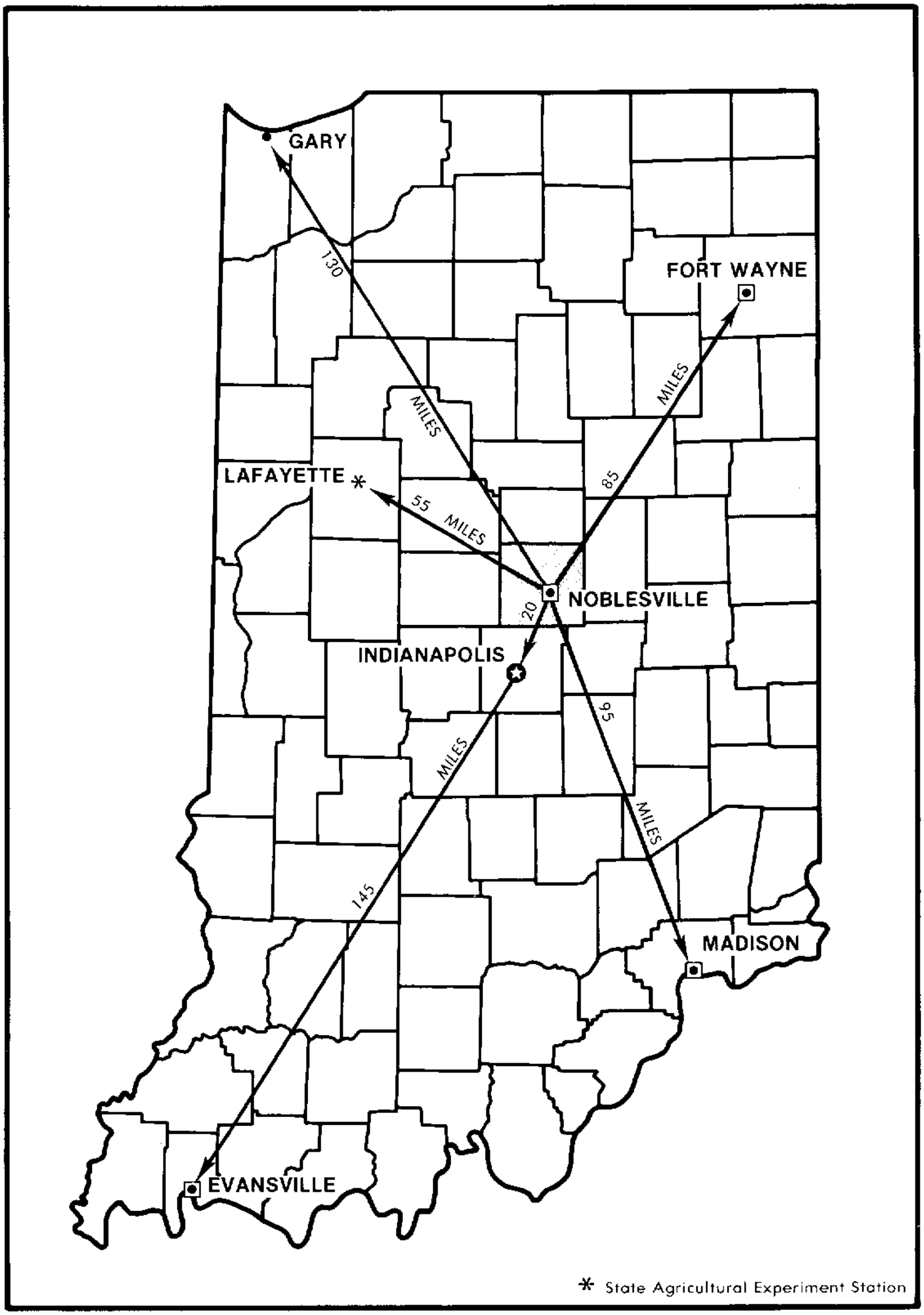
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Buell M. Ferguson

Buell M. Ferguson
State Conservationist
Soil Conservation Service



Location of Hamilton County in Indiana.

SOIL SURVEY OF HAMILTON COUNTY, INDIANA

By William D. Hosteter, Soil Conservation Service

Soils surveyed by Rex A. Brock, Charles Froehle,
Kelso K. Huffman, John R. Bernard, and William D. Hosteter

United States Department of Agriculture, Soil Conservation Service,
in cooperation with Purdue University Agricultural Experiment Station

HAMILTON COUNTY is in the central part of Indiana and has an area of 256,640 acres, or 401 square miles. Noblesville is the county seat.

The main farm enterprises are the growing of cash grain crops and the raising of livestock. Corn, soybeans, and wheat are the main crops. Much of the county has poor natural drainage and needs artificial drainage.

Recently, urban development has been extensive in the areas of Carmel and Noblesville. Construction of housing has greatly increased in rural areas throughout the southern half of the county. A large number of Hamilton County residents are employed in industry in Noblesville and in Indianapolis, which is in nearby Marion County.

Seed for corn and small grain crops is produced by two companies in the county. Grain is marketed mostly through local elevators or is sold to processing plants in Indianapolis. Livestock are marketed locally and in the Indianapolis area and directly to processors in neighboring counties.

Hamilton County has six public school corporations, and access to a public school is easy from any part of the county. A few private and parochial elementary schools also are in the county.

General nature of the county

In this section the relief, water supply, and climate of the county are described. In addition, the county's transportation facilities and trends in population and land use are discussed.

Relief

The highest elevation in Hamilton County, 964 feet above sea level, is in the northwestern corner of the county about 1 mile northwest of Sheridan. The lowest elevation, 700 feet, is at White River, where it exits the survey area and flows south into Marion County.

Hamilton County consists mainly of a flat plain that is dissected by the west fork of White River and by many creeks, streams, and drainageways. The county is entirely within the drainage basin of the west fork of White River. Low relief and few abrupt changes in elevation characterize the physiography of the county, except along White River where abrupt changes in elevation are common.

Water supply

Wells are the main source of water in Hamilton County. Many wells are used to supply water to cities and towns and are in gravel deposits along the west fork of White River and the larger streams. Most rural farmsteads have wells that extend deeply into glacial till.

Geist and Morse Reservoirs are in Hamilton County and supply water for industrial and municipal use in the southern part of the county. These reservoirs also supply water for the Indianapolis metropolitan area. It is expected that the water from these reservoirs will be adequate to supply county needs until 1980. Presently, there are plans to increase the capacity of Geist Reservoir.

The supply of ground water is sufficient in most areas of the county. The principal sources of ground water are in sand and gravel deposits overlying bedrock, in sand and gravel seams within the glacial till, and in limestone bedrock.

Climate

LAWRENCE A. SCHAAL, state climatologist, Department of Agronomy, Purdue University, helped to prepare this section.

Hamilton County has a humid continental climate and is on the fringe of climatic influence of the Great Lakes. Cool air masses from Canada alternate with tropical air masses from the south. The alternate flow of cool and warm air results in daily and seasonal variability in climate in the county.

Rainfall generally is adequate during the growing season for diversified farming. In midsummer, however, evaporation of water exceeds rainfall for brief periods, and occasionally there is a lack of sufficient moisture

available for use by lawns, pasture plants, and crops. Average annual precipitation is fairly evenly distributed throughout the year, but precipitation in spring and early in summer generally exceeds precipitation in winter. Spring rainfall is reliable and insures that a sufficient amount of moisture is in the soil for the growing season. In some years wetness delays planting in spring.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Noblesville and Whitestown for the period 1941 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring.

In winter the average temperature is 29 degrees F, and the average daily minimum temperature is 20 degrees. The lowest temperature on record, which occurred at Whitestown on January 18, 1930, is -24 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Whitestown on July 14, 1936, is 112 degrees.

Of the total annual precipitation, 21.6 inches, or 58 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 16.7 inches. The heaviest 1-day rainfall during the period of record was 5.0 inches at Noblesville on September 2, 1926. Thunderstorms occur on about 45 days each year, and about 8 thunderstorms occur in July.

Average annual snowfall is 21 inches. January and February each have an average monthly snowfall of 5 inches. On the average, 28 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity at noon is about 58 percent in summer and 68 percent in winter. Humidity is higher at night, and the average at dawn is about 95 percent. The percentage of possible sunshine is 72 in August and 40 in December. The prevailing wind is from the southwest. Average windspeed ranges from 7 miles per hour in September to 11 miles per hour in winter and early in spring. In a 53-year period of record, 7 tornadoes passed through the county.

Transportation facilities

Most of the state and federal highways in Hamilton County connect northern Indiana with the Indianapolis metropolitan area. Interstate 465 encircles the Indianapolis area, and its northern loop crosses the southern part of Hamilton County. Interstate 69 crosses the southeastern corner of the county, U.S. Highway 31 crosses the western part of the county from north to south, and U.S. Highway 421 crosses the southwestern corner of the county. A large network of state highways also is in the county. Most of the county roads are on section or half-section lines and provide easy access to most areas of the county. Most of the roads are paved.

One airport that is south of Noblesville and another that is north of Sheridan provide air freight and commuter service for the county. Many small airports in the county serve private planes.

Three railroad lines cross the county. One crosses the county from east to west and the others from north to south.

Trends in population and land use

Hamilton County has a population of about 60,000 and a population density of 150 per square mile. Population is expected to reach nearly 90,000 by the year 2000.

During the period 1958 to 1967, the acreage in urban land increased by 56 percent and the acreage in farmland decreased accordingly. About 88 percent of the county remains in farmland (*3*). Urban expansion is expected to continue at a higher rate, at the expense of farmland. Most of the urban development is in the southern part of the county.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for en-

gineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The soils in the survey area vary widely in their potential for major land uses. Table 3 shows the extent of the map units shown on the general soil map and gives general ratings of the potential of each, in relation to the other map units, for major land uses. Soil properties that pose limitations to the use are indicated. The ratings of soil potential are based on the assumption that practices in common use in the survey area are being used to overcome soil limitations. These ratings reflect the ease of overcoming the soil limitations and the probability of soil problems persisting after such practices are used.

Each map unit is rated for *cultivated farm crops, specialty crops, woodland, urban uses,* and *recreation areas.* Cultivated farm crops are those grown extensively by farmers in the survey area. Special crops include vegetables, fruits, and nursery crops grown on limited acreage and generally require intensive management. Woodland refers to land that is producing either trees native to the area or introduced species. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas include campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic. Extensive recreation areas include those used for nature study and as wilderness.

Descriptions of map units

1. Crosby-Brookston

Deep, nearly level, somewhat poorly drained and very poorly drained, medium textured and moderately fine textured soils that formed in a thin mantle of loess and the underlying glacial till on uplands

This map unit is on upland till plains that are characterized by swell and swale topography. These soils are mostly nearly level. Along drainageways and on slight rises, however, they are gently sloping or moderately sloping. Some of the soils have short slopes.

This map unit makes up about 59 percent of the county. About 47 percent of the unit is Crosby soils, 38 percent is Brookston soils, and 15 percent is soils of minor extent.

The nearly level, somewhat poorly drained Crosby soils are on broad flats and slight rises. The nearly level, very poorly drained Brookston soils are in depressional areas, swales, and narrow drainageways (fig. 1).

The soils of minor extent in this map unit are the well drained Miami soils, the somewhat poorly drained Whitaker soils, the poorly drained Patton soils, and the very poorly drained Houghton soils. Miami soils are on knobs and breaks along drainageways. Whitaker soils are on slight rises and are commonly near Patton soils. Patton and Houghton soils are in low lying pockets and depressions (fig. 2).

Nearly all areas of this map unit are used for cultivated crops. A few undrained areas are wooded or are in pasture. The growing of cash grain crops and the raising of hogs are the main farm enterprises. Wetness is the main limitation to the use of this map unit for urban and farm uses.

If adequately drained, this map unit has good potential for cultivated crops. It has poor potential for urban development because of wetness.

2. Miami-Crosby

Deep, nearly level to strongly sloping, well drained and somewhat poorly drained, medium textured soils that formed in a thin mantle of loess and the underlying glacial till on uplands

This map unit is on rolling till plains (fig. 3). Areas along the major streams are characterized by steep slopes and sharp breaks. In many places this map unit is dissected by drainageways.

This map unit makes up about 27 percent of the county. About 60 percent of the unit is Miami soils, 30 percent is Crosby soils, and 10 percent is soils of minor extent.

The Miami soils are well drained. Nearly level Miami soils are on flats, and gently sloping to strongly sloping Miami soils are on knobs and breaks. The nearly level and gently sloping, somewhat poorly drained Crosby soils are on broad flats and slight rises.

The soils of minor extent in this map unit are the very poorly drained Brookston soils, the somewhat poorly drained Shoals soils, and the well drained Fox, Genesee, and Hennepin soils. Brookston soils are in depressions and drainageways. Hennepin soils are on steep breaks. Fox soils are nearly level to moderately sloping and are underlain by thin layers of sand and gravel. Genesee and Shoals soils are on narrow flood plains.

Most areas of this map unit are used for cultivated crops, but in a few steep areas and on flood plains it is used for permanent pasture and wildlife habitat. The main farm enterprises are the growing of cash grain crops and the raising of beef cattle. Many of the steep areas are in woodland. Many areas in the southern part of the county are used for urban development. Erosion is the main hazard. Many areas require artificial drainage for optimum production.

The nearly level soils in this map unit have good potential for cultivated crops. This map unit has severe limitations for many nonfarm uses because of slope and permeability.

3. Ockley-Westland-Fox

Deep and moderately deep over sand and gravel, nearly level to strongly sloping, well drained and very poorly drained, medium textured and moderately fine textured soils that formed in outwash on terraces

This map unit is on stream terraces (fig. 4). The soils mostly are nearly level, but along drainageways and on slight rises they are gently sloping and strongly sloping. Short, steep breaks are along the flood plains.

This map unit makes up about 9 percent of the county. About 40 percent of the unit is Ockley soils, 20 percent is Westland soils, 15 percent is Fox soils, and 25 percent is soils of minor extent.

The Ockley soils are well drained. Nearly level Ockley soils are on broad flats, and gently sloping Ockley soils are on breaks. The nearly level, very poorly drained Westland soils are in depressional areas, swales, and drainageways (fig. 5). The Fox soils are well drained. Nearly level Fox soils are on flats, and gently sloping to strongly sloping Fox soils are on breaks and knobs.

The soils of minor extent in this map unit are the somewhat poorly drained Randolph Variant and Sleeth soils, the well drained Genesee, Miami, Milton Variant, and Nineveh soils, and the poorly drained Patton soils. Sleeth soils are in slight depressions. Nineveh soils are on low terraces. Miami soils are on upland breaks. Genesee soils are on flood plains. Patton soils are in depressions and drainageways. Milton Variant and Randolph Variant soils are in the east-central part of the county where limestone is near the surface (fig. 6).

In most areas this map unit is used for cultivated crops, but in a few sloping areas it is used for pasture. The main farm enterprise is the growing of cash grain crops. Many gravel pits are located in this map unit (fig. 7). Many areas are used for urban development.

The soils in this map unit, except the Fox soils, have good potential for cultivated crops. If the Fox soils are irrigated, they have good potential for many specialty crops. This map unit has good potential for most urban uses. Wetness in the Westland soils is the major limitation of this map unit for urban uses.

4. Shoals-Genesee

Deep, nearly level, somewhat poorly drained and well drained, medium textured soils that formed in alluvium on flood plains

This map unit is on flood plains. The topography is mostly flat, but some areas are dissected by overflow channels and drainageways (fig. 8).

This map unit makes up about 5 percent of the county. About 45 percent of the unit is Shoals soils, 25 percent is Genesee soils, and 30 percent is soils of minor extent.

Shoals soils are nearly level and somewhat poorly drained. Genesee soils are nearly level and well drained.

The soils of minor extent in this map unit are the very poorly drained Sloan soils and the well drained Fox, Miami, and Ross soils. Sloan soils are on the lowest parts of the flood plains. Fox soils are on slightly higher terraces. Miami soils are on upland breaks. Ross soils are on slightly higher flood plains along White River.

Most of this map unit is used for cultivated crops and pasture. In a few areas it is in woodland. The main farm enterprises are the growing of cash grain crops and the raising of beef cattle. Flooding is the main hazard. In most areas of Shoals soils, artificial drainage is needed to obtain optimum production.

If the soils of this map unit are protected from flooding and are adequately drained, they have good potential for cultivated crops. This map unit has severe limitations for most nonfarm uses because of the hazard of flooding.

Broad land use considerations

About 25,000 acres, or nearly 10 percent of the survey area, is urban or built-up land (*3*). Each year a considerable acreage is developed for urban uses in the townships of Noblesville, Clay, Delaware, Jackson, and Washington.

The general soil map can be used in planning a general location for urban development. It cannot be used, however, for the selection of sites for specific urban struc-

tures. Information about specific soils that is contained in this survey can be helpful in planning future land use patterns.

Extensive areas of soils that have severe limitations for urban development are in the survey area. The Shoals-Genesee map unit is on flood plains, and flooding is a severe hazard. Extensive artificial drainage is needed on the wet soils in the Crosby-Brookston map unit. The Crosby soils and the steeper Miami and Hennepin soils in the Miami-Crosby map unit have severe limitations for urban development.

The Ockley-Westland-Fox map unit has many sites that are more favorable for urban development than the soils named above. Ockley and Fox soils are well suited to urban development. Ockley soils, however, are also excellent farmland. Wetness is a limitation to use of the Westland soils for urban and farm uses. In the east-central part of the county, some of the soils in this map unit are underlain by limestone at a depth of 3 to 5 feet.

The Crosby-Brookston map unit has good potential for farming but has fair or poor potential for nonfarm uses. Wetness is a severe limitation to nonfarm uses of the Crosby, Brookston, and Patton soils in this map unit, but wetness can be offset by installation of properly designed surface and subsurface drainage systems. Many farmers have installed sufficient drainage on cropland in this map unit.

The Ockley and Fox soils in the Ockley-Westland-Fox map unit are suited to vegetables and other special crops. Proper drainage is needed on the Westland soils to obtain optimum production. The organic soils in scattered areas throughout the county also are suited to these crops. The Fox and Ockley soils are well drained and warm earlier in spring than finer textured, wetter soils. These well drained soils are also well suited to nursery plants.

Most of the soils in the survey area have good or fair potential for woodland. Commercially valuable trees are less common and generally grow less rapidly on the wetter soils in the Crosby-Brookston and Shoals-Genesee map units than on the soils in other map units.

The Miami-Crosby map unit has good potential for parks and other extensive recreation areas. Hardwood forests enhance the scenery in some areas of this map unit. Undrained areas in the Crosby-Brookston map unit have good potential as nature study areas. All of the map units in the survey area provide habitat for many important species of wildlife.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Ockley series, for example, was named for the town of Ockley in Carroll County, Indiana.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Ockley silt loam, 0 to 2 percent slopes, is one of several phases within the Ockley series.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions and potentials

Br—Brookston silty clay loam. This nearly level, deep, very poorly drained soil is in broad depressions, swales, and narrow drainageways on till plains. It is ponded by runoff from higher adjacent areas. The mapped areas are mostly oval shaped or fingerlike and range from 3 to 250 acres in size.

In a typical profile the surface layer is very dark grayish brown and very dark gray silty clay loam about 11 inches thick. The subsoil extends to a depth of 58 inches and is dark gray, gray, and grayish brown, mottled, firm clay loam and loam. The substratum, to a depth of 70 inches, is brown loam. In some places this soil is silty clay loam to a depth of 40 inches. In some places the lower part of the subsoil is sandy loam, loamy sand, or sandy clay loam. Lighter colored material has been deposited on the original surface layer in a few areas.

Included with this soil in mapping are small areas of Patton soils that generally are in the lowest part of depressions. Also included are Whitaker and Crosby soils in small, slightly convex areas. In a few small areas along drainageways, soils that have slopes of more than 2 percent are also included.

Permeability is moderate and the water table is commonly at the surface or is at a depth of less than 1 foot in winter and early in spring. Available water capacity is high, and content of organic matter in the surface layer is high. Surface runoff is ponded or is very slow. The surface layer is cloddy and hard to work if the soil is tilled when it is too wet.

This soil is commonly used for cultivated crops. It is well suited to growing corn, soybeans, and small grain if it is adequately drained. In most areas this soil has been drained with subsurface tile, surface drains, or open ditches or with some combination of these. Conservation practices, including minimum tillage and the use of crop residue management, help to improve and maintain tilth and to increase the content of organic matter.

This soil is suited to grasses and legumes for hay or pasture, but drainage is needed to obtain optimum production. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, timely grazing, and restricting grazing during wet periods help to reduce compaction and to maintain good tilth and plant density.

This soil is suited to trees, and in a few areas it is used for trees. Equipment limitations, plant competition, and seedling mortality are severe. The hazard of windthrow is moderate. Species that can tolerate wetness grow best. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, and girdling.

Many areas of this soil in the southern part of the county are used for urban development.

The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, moderate shrink-swell potential, and moderate permeability.

This soil has severe limitations for building sites. The sites need to be artificially drained and protected from flooding. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from frost action and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets because of a seasonal high water table and high potential frost action. Installation of drainage ditches along roads helps to lower the water table and prevent damage from frost action. The base material for roads and streets should be replaced or strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of a seasonal high water table. Sanitary facilities should be connected to sewers and treatment facilities. Capability subclass IIw; woodland suitability subclass 2w.

CrA—Crosby silt loam, 0 to 3 percent slopes. This nearly level, deep, somewhat poorly drained soil is on slight rises on broad, undulating till plains. The mapped areas are irregular in shape and range from 3 to 200 acres in size.

In a typical profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is dark yellowish brown and yellowish brown, mottled, firm silty clay loam and clay loam about 21 inches thick. The underlying material, to a depth of 60 inches, is brown, calcareous loam. In some areas the lower part of the subsoil is stratified silt loam, sandy loam, and sand as much as 12 inches thick. In some areas the content of gravel in the subsoil is as much as 10 percent. The depth to firm glacial till is more than 40 inches in many areas.

Included with this soil in mapping are Brookston soils in depressions. Also included are small areas of Whitaker soils, many small domelike areas of Miami soils, and small areas of Crosby soils that have slopes of more than 3 percent. Small areas of eroded and severely eroded soils are included in the more sloping areas.

Permeability is slow. Content of organic matter in the surface layer is moderate. Available water capacity is high. The water table is commonly at a depth of 1 to 3 feet in winter and early in spring. Surface runoff is slow. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

Most areas are used for corn, soybeans, and small grain. This soil is well suited to these crops if it is adequately drained. Most areas are drained by subsurface tile and open ditches. Conservation practices, including minimum tillage and returning crop residue to the soil, help to maintain the content of organic matter and good tilth.

Some areas of this soil are used for hay and pasture. In some undrained areas this soil can be used for grasses and legumes and for hay and pasture, but artificial drainage generally is beneficial. This soil is better suited to shallow-rooted crops than to deep-rooted legumes, for

example, alfalfa. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely grazing, and restricting grazing during wet periods help to reduce surface compaction and maintain good tilth and plant density.

This soil is suited to trees, and a few areas are used for orchards or woodland. In some years seasonal wetness slightly delays harvesting and planting operations. Species that can tolerate wetness grow best. Plant competition is the main limitation to the use of this soil for trees. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, and girdling.

Many areas of this soil in the southern part of the county are used for urban development.

The main soil features that adversely affect the engineering uses of this soil are a seasonal high water table, moderate shrink-swell potential, high potential frost action, and slow permeability.

This soil has some severe limitations for building sites. The sites need to be artificially drained to prevent wetness from becoming a problem. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets. Drainage ditches can be used along roads to lower the water table and to help prevent damage from frost action. The base material for roads needs to be strengthened or replaced with suitable material. Sanitary facilities should be connected to sewers and treatment facilities, or a large absorption field can be used to offset slow permeability when the water table is lowered through artificial drainage. Capability subclass IIw; woodland suitability subclass 3o.

FnA—Fox loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad terraces and on small knolls on uplands. It is moderately deep over sand and gravelly sand. Most mapped areas on terraces are elongated and are parallel to streams; these areas range from 3 to 150 acres in size. The mapped areas on uplands are irregular in shape and range from 3 to 10 acres in size.

In a typical profile the surface layer is dark brown loam about 8 inches thick. The subsurface layer is dark brown loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part of the subsoil is dark brown, firm clay loam or gravelly clay loam, and the lower part is reddish brown and dark reddish brown, firm or friable sandy clay loam and gravelly sandy clay loam. The underlying material, to a depth of 60 inches, is brown, calcareous sand and gravelly coarse sand. In some areas the surface layer is gravelly or cobbly. In small areas on uplands the depth to loam till is 40 to 60 inches.

Included with this soil in mapping are a few small areas of Sleeth soils in slight depressions, small areas of Ockley soils, areas of shallow soils on steep breaks, and some areas of soils that have slopes of more than 2 percent.

Permeability is moderate in the subsoil and rapid in the underlying material. Available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff is slow. The surface layer of this soil is friable and is easy to till within a wide range of moisture content. This soil is droughty during dry periods.

Most areas are used for cultivated crops. This soil is well suited to small grains and fall-seeded crops and is suited to corn and soybeans. Conservation practices that include minimum tillage and the return of crop residue to the soil help to maintain content of organic matter and good tilth.

A few areas are used for hay and pasture crops. This soil is well suited to grasses and deep-rooted legumes. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

A few small areas are used for woodland. This soil is well suited to trees, and limitations in woodland management are slight. Seedlings survive and grow well if competing vegetation is controlled.

The main soil features that affect engineering uses of this soil are moderate potential frost action, moderate permeability in the subsoil, rapid permeability in the underlying material, and moderate shrink-swell potential.

This soil has slight limitations for building sites and septic tank absorption fields. It has moderate limitations for local roads and streets because of shrink-swell potential. The base material for roads needs to be strengthened or replaced with suitable material.

This soil is used as a source of sand and gravel, and many pits are in operation. The best gravel sources are in areas along White River. Capability subclass IIs; woodland suitability subclass 2o.

FnB2—Fox loam, 2 to 6 percent slopes, eroded. This gently sloping, well drained soil is on broad terraces and in small domelike areas on uplands. It is moderately deep over sand and gravelly coarse sand. Most mapped areas on terraces are elongated and range from 3 to 50 acres in size. The mapped areas on uplands are irregular in shape and range from 3 to 15 acres in size.

In a typical profile the surface layer is dark brown loam about 6 inches thick. The subsoil is about 30 inches thick. The upper part of the subsoil is dark yellowish brown loam; the next part is dark brown, firm clay loam and gravelly clay loam; and the lower part is reddish brown and dark reddish brown, firm gravelly sandy clay loam and sandy clay loam. The underlying material, to a depth of 60 inches, is brown, calcareous sand and gravelly coarse sand. In some areas the surface layer is cobbly or gravelly. In some areas on uplands, the underlying material is thin and loam till is at a depth of less than 60 inches. In some areas adjacent to areas of Nineveh soils, this soil has a darker colored surface layer.

Included with this soil in mapping are Sleeth soils in slight depressions. Also included are small areas of soils that have slopes of more than 6 percent, areas of shallow

soils on steep breaks, and small areas of severely eroded soils.

Permeability is moderate in the subsoil and rapid in the underlying material. Available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff is medium. The surface layer of this soil is friable and is easy to till within a wide range of moisture content. This soil is droughty during dry periods.

This soil is suited to corn, soybeans, and small grains, but conservation practices are needed to control erosion and surface runoff. Crop rotation, minimum tillage, contour farming, and the use of terraces, diversions, grassed waterways, and grade stabilization structures help to prevent excessive soil losses from erosion. The use of crop residue and cover crops helps to control erosion, to maintain tilth, and to increase the content of organic matter.

This soil is suitable for hay and pasture crops, and in a few areas it is used for these crops. The growing of grasses and legumes helps to control soil blowing and erosion. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

A few small areas are used for woodland. This soil is suited to trees, and the hazards and limitations in woodland management are slight, except plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, girdling, or spraying.

Many areas of this soil in the southern part of the county are used for urban development.

The main soil features that adversely affect engineering uses are moderate frost action potential, moderate shrink-swell potential, moderate permeability in the subsoil, and rapid permeability in the underlying material.

This soil has slight limitations for building sites and septic tank absorption fields. It has moderate limitations for local roads and streets because of moderate shrink-swell potential. The base material for roads needs to be strengthened with suitable material.

In areas along the larger streams, this soil is used as a source of sand and gravel. Many pits are in operation. Capability subclass IIe; woodland suitability subclass 2o.

FxC3—Fox clay loam, 8 to 18 percent slopes, severely eroded. This moderately sloping, well drained soil is on side slopes adjacent to drainageways on terraces and in domelike areas on uplands. It is moderately deep over sand and gravelly sand. The mapped areas on terraces are mostly elongated and are parallel to streams; these areas range from 3 to 40 acres in size. The mapped areas on uplands are irregular in shape and range from 3 to 20 acres in size.

In a typical profile the surface layer is dark brown clay loam about 7 inches thick. The subsoil is about 21 inches thick. The upper part of the subsoil is dark brown, firm clay loam and gravelly clay loam, and the lower part is reddish brown and dark reddish brown, firm sandy clay loam and gravelly sandy clay loam. The underlying material, to a depth of 60 inches, is calcareous sand and gravelly sand. In some areas the surface layer is gravelly clay loam. In some uneroded areas the surface layer is loam. In some areas on uplands, the underlying outwash material is thin and depth to loam till is less than 60 inches.

Included with this soil in mapping are areas of soils that have slopes of more than 18 percent and small areas of Miami soils.

Permeability is moderate in the subsoil and rapid in the underlying material. Available water capacity is low. Content of organic matter in the surface layer is low. Surface runoff is medium. Because of poor soil structure and the low content of organic matter, the surface layer becomes cloddy if the soil is tilled when it is too wet.

This soil is poorly suited to corn, soybeans, and small grains because of slope, hazard of erosion, and low available water capacity. However, in some areas it is used for these crops. Conservation practices are needed to control erosion and surface runoff in cultivated areas. Crop rotation, minimum tillage, contour farming, and the use of terraces, diversions, grassed waterways, and grade stabilization structures help to prevent excessive soil losses from erosion. The use of crop residue and cover crops helps to control erosion, to improve and maintain tilth, and to increase the content of organic matter.

This soil is suited to hay and pasture crops, and many areas are used for these crops. The growing of grasses and legumes helps to control erosion. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is suited to trees, and some areas are used for trees. The hazards and limitations in woodland management are slight. Seedlings survive and grow well if competing vegetation is controlled.

The main soil features that adversely affect engineering uses are moderate potential frost action, moderate shrink-swell potential, moderate permeability in the subsoil, and rapid permeability in the underlying material.

This soil has moderate limitations for building sites. Slope is a moderate limitation for dwellings and is a severe limitation for small commercial buildings. Small commercial buildings should be constructed on less sloping soils. Removal of vegetation should be kept to a minimum. Topsoil should be stockpiled for use in exposed areas, and a plant cover should be established as soon as possible after construction. Local roads and streets should be built on the contour. The base material for roads and streets needs to be strengthened with suitable material. Slope is a moderate limitation for septic tank absorption fields. Capability subclass IVe; woodland suitability subclass 2o.

Ge—Genesee silt loam. This nearly level, deep, well drained soil is on flood plains and is frequently flooded. The mapped areas are mostly elongated and are parallel to streams. They range from 3 to 100 acres in size.

In a typical profile the surface layer is dark grayish brown silt loam about 7 inches thick. The underlying material is brown, friable silt loam or loam to a depth of 38 inches and is brown, stratified loam and silt loam to a depth of 60 inches. In some areas carbonates are absent throughout the profile. This soil has a darker colored surface layer in some areas along the west fork of White River.

Included with this soil in mapping are small areas of Shoals soils. Also included are areas of soils that have loose sand and gravelly sand below a depth of 18 inches.

Permeability is moderate. Content of organic matter in the surface layer is moderate. Available water capacity is high. Surface runoff is slow. The surface layer of this soil is friable and is easy to till within a wide range of moisture content.

Most areas are used for corn, soybeans, and small grain. This soil is suited to these crops, but flooding may cause damage to crops planted in fall and early in spring. In a few areas the soil is protected by levees. Minimum tillage, return of crop residue to the soil, and the use of cover crops help to maintain and increase the content of organic matter and to maintain good tilth.

This soil is suited to grasses and legumes, but flooding may cause damage to these plants in winter and early in spring. Proper stocking rates, pasture rotation, timely grazing, and restricting grazing when the soil is wet help to keep the soil in good condition.

This soil is well suited to woodland, but it is used for trees only in small inaccessible areas and in areas that are dissected by overflow channels. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate permeability, and frequent flooding.

Flooding is a severe limitation to the use of this soil for building sites, local roads and streets, and sanitary facilities. Capability subclass IIIw; woodland suitability subclass 1o.

HeF—Hennepin loam, 18 to 50 percent slopes. This moderately steep to very steep, deep, well drained soil is on short breaks on uplands. Slopes are mostly 25 to 40 percent and are 50 to 100 feet long. The mapped areas range from 5 to 30 acres in size and are commonly dissected by drainageways.

In a typical profile the surface layer is dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown, friable loam about 7 inches thick. The underlying material, to a depth of 60 inches, is brown loam. In places the subsoil is thicker.

Included with this soil in mapping are small areas of severely eroded soils. Also included are areas of steep soils that have a subsoil of gravelly clay loam or gravelly loam and a substratum of loose sand and gravel to a depth of about 4 feet. These steep, gravelly soils are near Fox and Ockley soils. Also included are small areas of gently sloping to strongly sloping Miami soils on ridgetops and side slopes.

Permeability is moderately slow. Available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff is rapid or very rapid.

This soil is not suited to row crops or small grains because the slopes are moderately steep to very steep.

This soil is generally unsuited to hay crops, because the moderately steep to very steep slopes hinder establishment of plants and operation of machinery. It is suited to permanent pasture in areas where slopes are about 18 percent, and a few areas are used for pasture. Timely grazing and pasture rotation help to keep the pasture plants and soil in good condition.

This soil is well suited to trees, and in most areas it is used for trees. The equipment limitation is severe, and plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

The main soil factors that adversely affect engineering uses of this soil are moderately steep to very steep slopes, moderately slow permeability, moderate potential frost action, and hazard of erosion. Areas of this soil which have layers of sand and gravel are susceptible to slippage.

This soil has severe limitations for building sites, sanitary facilities, and local roads and streets because of the steepness of the slopes. On short, steep breaks it is best to leave this soil in woodland and to use adjacent, less sloping soils for building sites. Capability subclass VIIe; woodland suitability subclass 1r.

Ho—Houghton muck. This nearly level, deep, very poorly drained soil is in depressions on uplands and outwash terraces. Runoff from higher adjacent areas is ponded on this soil. The mapped areas are mostly oval in shape and range from 2 to 60 acres in size.

In a typical profile the surface layer is black muck about 5 inches thick. Below this, the material is black or dark reddish brown, friable muck to a depth of 37 inches. Below this is very dark gray, friable muck to a depth of 60 inches. In some areas the organic material is not so well decomposed.

Included with this soil in mapping are small areas of Palms soils. Also included are small areas of Patton soils around the edge of depressions.

Permeability is moderately rapid. In winter and spring the water table is at the surface or is at a depth of less than 1 foot. Available water capacity is very high. Content of organic matter in the surface layer is very high. Surface runoff is ponded or is very slow. The surface layer of this soil is friable and can be tilled within a wide range of moisture content.

Most areas of this soil are idle, and wetland weeds and shrubs are the dominant vegetation. One area is used as a source of muck for commercial purposes.

This soil is well suited to corn and soybeans if it is adequately drained, and a few areas are drained and are used for these crops. Drainage is difficult, however, because of a lack of adequate outlets. Subsidence is com-

monly a problem after drainage has been established. Small grain that is planted in fall and early in spring may be damaged by ponded water in winter and early in spring, even where satisfactory drainage for row crops has been established. The use of crop residue and cover crops helps to prevent soil blowing and to maintain soil tilth.

Desirable grasses and legumes do not grow well on this soil unless drainage is established. A few areas are used for pasture. In some of the areas that are used for pasture, the forage consists mainly of wetland weeds. Even if the soil is drained, however, these areas are commonly ponded in winter and spring.

This soil is not suited to trees except for a few water-tolerant species. Hazards and limitations in woodland management are severe, except the hazard of erosion is slight.

The main soil features that adversely affect engineering uses of this soil are high potential frost action, a seasonal high water table, and poor stability.

This soil has severe limitations for building sites and sanitary facilities because of flooding, the high water table, and poor stability. This soil is in the lowest position on the landscape, and in most areas suitable drainage outlets are not available. Pumping stations may be needed. Because of low strength and subsidence, buildings should not be constructed on this soil. Capability subclass IIIw; woodland suitability subclass 4w.

MmA—Miami silt loam, 0 to 2 percent slopes. This nearly level, deep, well drained soil is on slight rises on uplands. The mapped areas are irregular in shape and range from 3 to 60 acres in size.

In a typical profile the surface layer is brown silt loam about 8 inches thick. The subsurface layer is dark yellowish brown, friable silt loam about 5 inches thick. The subsoil extends to a depth of 38 inches and is dark yellowish brown and brown, friable or firm clay loam. The calcareous substratum, to a depth of 60 inches, is yellowish brown loam. In many areas, the lower part of the subsoil is stratified sandy loam, silt loam, or sand and the firm, calcareous loam till is at a depth of more than 40 inches. In some areas the lower part of the subsoil is gravelly clay loam or gravelly sandy clay loam. In a few areas the lower part of the subsoil has gray mottles. In some areas layers of sand and gravelly sand are in the substratum at a depth of 6 to 10 feet.

Included with this soil in mapping are small areas of Crosby soils in slight depressions. Also included are small areas of soils that have slopes of more than 2 percent.

Permeability is moderate in the subsoil and in the substratum. Content of organic matter in the surface layer is moderate. Available water capacity is high. Surface runoff in cultivated areas is slow. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

This soil is well suited to corn, soybeans, and small grains, and in most areas it is used for these crops. Minimum tillage, returning crop residue to the soil, and using cover crops help to maintain the content of organic matter and good tilth.

This soil is well suited to grasses and legumes for hay or pasture, and some areas are used for these crops. The major concerns of pasture management are overgrazing and grazing when the soil is wet. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is well suited to trees, but only a few areas are used for trees (fig. 9). The hazards and limitations in woodland management are slight, except plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

This soil is suitable for urban development. Many areas are used for this purpose in the southern part of the county.

The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate permeability, and moderate shrink-swell potential.

This soil has moderate limitations for building sites. Using properly designed foundations, footings, and basement walls and using foundation drain tile help to prevent structural damage from shrinking and swelling and low strength of the soil.

This soil is poorly suited to septic tank absorption fields, and moderate permeability is a moderate limitation. Using a large filter field helps to prevent surfacing of the effluent from lateral seepage across the top of the till.

This soil has severe limitations for local roads and streets. The base material for local roads and streets needs to be strengthened with suitable material. Capability class I; woodland suitability subclass 1o.

MmB2—Miami silt loam, 2 to 6 percent slopes, eroded. This gently sloping, deep, well drained soil is on rises on till plains and along drainageways and streams. The mapped areas range from 3 to 50 acres in size.

In a typical profile the surface layer is dark grayish brown silt loam about 7 inches thick. The subsoil is dark yellowish brown and brown, firm clay loam about 23 inches thick. The substratum, to a depth of 60 inches, is yellowish brown loam that contains free carbonates. In a few areas the lower part of the subsoil is stratified sandy loam, loamy sand, and sandy clay loam. The depth to till is more than 40 inches in some areas.

Included with this soil in mapping are small areas of Crosby soils, small areas of severely eroded soils that have a surface layer of clay loam, small areas of soils that have slopes of more than 6 percent, and small areas of soils that have gravel and cobbles on the surface.

Permeability is moderate in the subsoil and moderately slow in the underlying till. Content of organic matter in the surface layer is moderate. Available water capacity is high. Surface runoff is medium. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

In most areas this soil is used for corn, soybeans, and small grains. It is suited to these crops, but conservation practices are needed to control erosion and surface runoff in cultivated areas. Crop rotation, minimum tillage, contour farming, and the use of terraces, diversions, grassed waterways, and grade stabilization structures help to prevent excessive soil losses from erosion. The use of crop residue and cover crops helps to control erosion, improve and maintain tilth, and increase the content of organic matter. Seepage areas in some drainageways and swales need subsurface tile for adequate drainage.

This soil is suitable for hay and pasture crops, and in some areas it is used for these crops. The growing of grasses and legumes helps to control erosion. Overgrazing and grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is well suited to trees, but it is used for trees in only a few areas. The limitations and hazards in woodland management are slight, except plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderately slow permeability, moderate shrink-swell potential, and low strength. Erosion is a hazard during construction.

This soil is suitable for building sites, but slope, clayey texture, shrinking and swelling, and low strength are moderate limitations that need to be overcome. Using properly designed foundations, footings, and basement walls and using foundation drain tile help to prevent structural damage from shrinking and swelling and low strength.

This soil is poorly suited to septic tank absorption fields, and moderately slow permeability is a severe limitation. Using a larger filter field helps to prevent surfacing of the effluent from lateral seepage across the top of the till.

Low strength is a severe limitation to the use of this soil for local roads and streets. The base material for roads and streets needs to be strengthened with suitable material. Capability subclass IIe; woodland suitability subclass 1o.

MmC2—Miami silt loam, 6 to 12 percent slopes, eroded. This moderately sloping, deep, well drained soil is on knobs and breaks along streams and drainageways on uplands. The mapped areas are irregular in shape and range from 3 to 25 acres in size.

In a typical profile the surface layer is brown silt loam about 5 inches thick. The subsoil is brown or dark yellowish brown, firm clay loam about 22 inches thick. The substratum, to a depth of 60 inches, is yellowish brown, calcareous loam. In many areas the solum is less than 24 inches thick. In some areas the subsoil is redder and contains more gravel.

Included with this soil in mapping are areas of severely eroded soils that have a surface layer of clay loam; in many of these areas cobbles and gravel are on the surface. Also included are small areas of soils that have slopes of more than 12 percent.

Permeability is moderate in the subsoil and moderately slow in the substratum. Content of organic matter in the surface layer is moderate. Available water capacity is moderate. Surface runoff is medium. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

This soil is suitable for corn, soybeans, and small grains. Some areas are used for these crops. The hazard of erosion is severe in cultivated areas. Crop rotation, minimum tillage, contour farming, and the use of terraces, diversions, grassed waterways, and grade stabilization structures help to control erosion. Proper use of crop residue and cover crops helps to reduce runoff and control erosion.

This soil is suitable for hay and pasture crops, and in most areas it is used for these crops. The growing of grasses and legumes helps to control water erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is used for woodland in a few areas. It is well suited to trees, and the limitations and hazards in woodland management are slight, except plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, and girdling.

This soil is suitable for urban development. Many areas are used for this purpose in the southern part of the county.

The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate shrink-swell potential, and moderately slow permeability. The hazard of erosion is severe during construction.

This soil has moderate limitations for building sites. Using properly designed foundations, footings, and basement walls and using foundation drain tile help to remove excess water and to prevent structural damage from shrinking and swelling and low strength of the soil. Removal of vegetation should be kept to a minimum. Topsoil should be stockpiled for use in exposed areas, and a plant cover should be established as soon as possible after construction is completed. Diversions and waterways can be installed between building sites to divert excess runoff to suitable outlets.

This soil has severe limitations for local roads and streets. The base material for local roads and streets needs to be strengthened with suitable material. Roads and streets should be constructed on the contour of slopes.

This soil is poorly suited to septic tank absorption fields. The moderately slow permeability is a severe

limitation. Using a large filter field helps to prevent surfacing of the effluent from lateral seepage across the top of the till. Capability subclass IIIe; woodland suitability subclass 1o.

MmD2—Miami silt loam, 12 to 18 percent slopes, eroded. This strongly sloping, deep, well drained soil is on breaks along streams and drainageways. Slopes are short. The mapped areas are irregular in shape and range from 3 to 15 acres in size.

In a typical profile the surface layer is brown silt loam about 5 inches thick. The subsoil is dark yellowish brown, firm clay loam about 20 inches thick. The substratum, to a depth of 60 inches, is yellowish brown, calcareous loam. In many areas the combined thickness of the surface layer and subsoil is less than 24 inches. In some small areas the subsoil is gravelly. In some areas thin layers of sand and gravel are in the substratum.

Included with this soil in mapping are areas of severely eroded soils that have a surface layer of clay loam or have a gravelly surface layer. Also included are small areas of soils that have slopes of more than 18 percent.

Permeability is moderate in the subsoil and moderately slow in the substratum. Content of organic matter in the surface layer is moderate. Available water capacity is moderate. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

This soil is generally unsuited to corn, soybeans, and small grains, but a few areas are used for these crops. The hazard of erosion is severe, and conservation practices are needed to control surface runoff in cultivated areas. Practices that help to prevent excessive soil losses include minimum tillage, the use of diversions and grassed waterways, and returning crop residue to the soil.

This soil is suitable for hay and pasture crops, and in most areas it is used for these crops. The growing of grasses and legumes for hay or pasture helps to control water erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is well suited to woodland, and in many areas it is used for trees. The limitations and hazards in woodland management are slight, except plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, and girdling.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses are moderate potential frost action, moderate shrink-swell potential, and moderately slow permeability. The hazard of erosion is severe during construction.

The soil has severe limitations for building sites because of slope. Removal of vegetation should be kept to a minimum, and the exposed areas should be reseeded or sodded as soon as possible. Operations of some types of machinery across the slope is somewhat hazardous. Using properly designed foundations, footings, and basement walls and using foundation drains help to remove excess water and to prevent structural damage from shrinking and swelling and low strength of the soil.

This soil has severe limitations for local roads and streets. Roads and streets should be constructed on the contour, and their base material should be strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of moderately slow permeability and slope. Using a large absorption field helps to prevent surfacing of the effluent from lateral seepage across the top of the hill. Capability subclass IVe; woodland suitability subclass 1o.

MoC3—Miami clay loam, 6 to 12 percent slopes, severely eroded. This moderately sloping, deep, well drained soil is on knobs and breaks along streams and drainageways on uplands. The mapped areas are irregular in shape and range from 3 to 35 acres in size.

In a typical profile the surface layer is dark brown clay loam about 5 inches thick. The subsoil is dark yellowish brown, firm clay loam about 19 inches thick. The substratum, to a depth of 60 inches, is yellowish brown loam. Combined thickness of the surface layer and subsoil is less than 24 inches. Calcareous glacial till is at the surface on about 15 percent of the acreage of this map unit. In some areas cobbles and gravel are in the surface layer. In some small areas the surface layer is uneroded and is loam or silt loam.

Included with this soil in mapping are small areas of steep soils that have short slopes.

Permeability is moderate in the subsoil and moderately slow in the substratum. Content of organic matter in the surface layer is low. Available water capacity is moderate. Surface runoff is medium. The surface layer is cloddy and difficult to work if the soil is tilled when it is wet, because of poor soil structure and low content of organic matter. Seed germination is commonly slow in this soil.

This soil is used for crops in most areas. It is poorly suited to corn and soybeans, because the surface layer is severely eroded and the hazard of further erosion is severe. Small grains can be grown occasionally to aid the reestablishment of grasses and legumes. Conservation practices including minimum tillage, the use of diversions and grassed waterways, and returning crop residue to the soil help to prevent excessive soil loss. Using a cropping system that consists mainly of grasses and legumes helps to control erosion.

This soil is suited to grasses and legumes for forage and pasture, and in some areas it is used for these crops. Small gullies that are difficult to cross with farm machinery are in some areas. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the soil and pasture plants in good condition.

This soil is suited to trees, but in several areas the quality of stands of young trees is poor. The limitations and hazards in woodland management are slight, except

plant competition is moderate. Because the surface layer of this soil is severely eroded, the rate of seedling survival is lower than in areas of uneroded Miami soils. Competing vegetation needs to be controlled by cutting, spraying, and girdling.

This soil is suitable for urban development, and some areas are used for this purpose. The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate shrink-swell potential, and moderately slow permeability. The hazard of further erosion is severe during construction.

This soil has moderate limitations for building sites. Using properly designed foundations, footings, and basement walls and using foundation drains help to remove excess water and to prevent structural damage from shrinking and swelling and low strength of the soil.

Removal of vegetation should be kept to a minimum. Topsoil should be stockpiled for use in exposed areas, and vegetation should be reestablished as soon as possible. Diversions and waterways can be used between lots to divert excess runoff to suitable outlets.

This soil has severe limitations for local roads and streets. Roads and streets should be constructed on the contour, and their base material needs to be strengthened with suitable material.

This soil is poorly suited to septic tank absorption fields. The moderately slow permeability in the substratum is a severe limitation. Using a large filter field helps to prevent surfacing of the effluent from lateral seepage across the top of the till. Capability subclass IVe; woodland suitability subclass 1o.

MoD3—Miami clay loam, 12 to 18 percent slopes, severely eroded. This strongly sloping, deep, well drained soil is on breaks along streams and drainageways. The mapped areas are irregular in shape and range from 3 to 15 acres in size.

In a typical profile the surface layer is dark brown clay loam about 5 inches thick. The subsoil is dark yellowish brown, firm clay loam about 19 inches thick. The substratum, to a depth of 60 inches, is yellowish brown loam. In some areas calcareous glacial till is at the surface. Cobbles and gravel are in the surface layer in most areas. In many areas the subsoil is gravelly loam or clay loam.

Included with this soil in mapping are small areas of steep soils that have short slopes.

Permeability is moderate in the subsoil and moderately slow in the substratum. Content of organic matter in the surface layer is low. Available water capacity is moderate. Surface runoff is very rapid. The surface layer is very cloddy and difficult to work if the soil is tilled when it is too wet, because of poor soil structure and low content of organic matter. Seed germination is generally slow in this soil.

In many areas, this soil is idle and the vegetation consists of briars and young trees.

In some areas this soil is used for crops. It is generally unsuited to corn and soybeans, because the surface layer is severely eroded and the hazard of further erosion is severe. Small grains can occasionally be grown to aid the reestablishment of grasses and legumes. Minimum tillage, the use of diversions and grassed waterways, and returning crop residue to the soil are practices that help to prevent erosion. Using a cropping system that consists mainly of grasses and legumes helps to control erosion.

This soil is suited to grasses and legumes for forage and pasture, and in some areas it is used for these crops. New stands are difficult to establish, however, because the surface layer is severely eroded. Gullies that are difficult to cross with farm machinery are in some areas. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the soil and pasture plants in good condition.

This soil is suited to trees. The limitations and hazards in woodland management are slight, except plant competition is moderate. Because the surface layer is severely eroded, the rate of seedling survival is lower than in areas of uneroded Miami soils. Seedlings grow well if competing vegetation is controlled by cutting, spraying, or girdling.

This soil is poorly suited to urban development. The soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate shrink-swell potential, and moderately slow permeability. The hazard of further erosion is severe during construction.

This soil has severe limitations for building sites because of slope. Removal of vegetation should be kept to a minimum, and exposed areas should be reseeded or sodded as soon as possible. Operation of some kinds of machinery across the slope is somewhat hazardous. Using properly designed foundations, footings, and basement walls and using foundation drains help to remove excess water and to prevent structural damage from shrinking and swelling and low strength of the soil.

This soil has severe limitations for roads and streets because of slope. Roads and streets could be constructed on the contour, and their base material should be strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of slope and moderately slow permeability in the substratum. Using a larger filter field helps to prevent surfacing of the effluent from lateral seepage across the top of the till. Capability subclass VIe; woodland suitability subclass 1o.

MxA—Milton Variant silt loam, 0 to 2 percent slopes. This nearly level, deep, well drained soil is on slight rises on terraces. Most mapped areas are elongated and are parallel to streams. The areas range from 3 to 80 acres in size.

In a typical profile the surface layer is brown silt loam about 8 inches thick. The subsoil is about 33 inches thick. The upper part of the subsoil is strong brown silt loam, the next part is dark brown and reddish brown clay loam, and the lower part is dark reddish brown flaggy clay and flaggy clay loam. The substratum, to a depth of 46 inches,

is light brownish gray and light gray soft limestone. Hard limestone is at a depth of 46 inches. In some areas the depth to hard limestone is as much as 60 inches or as little as 24 inches. In some areas the lower part of the subsoil ranges in texture from gravelly loam to clay and in reaction from slightly acid to mildly alkaline.

Included with this soil in mapping are small areas of Randolph Variant soils on slightly lower positions. Also included are areas of soils that have slopes of more than 2 percent; these soils commonly are eroded and have cobbles and gravel on the surface.

This soil is suitable for corn, soybeans, and small grains, and in most areas it is used for these crops. Conservation practices that include returning crop residue to the soil and minimum tillage help to improve and maintain tilth and to increase the content of organic matter.

This soil is well suited to hay and pasture crops, and in a few areas it is used for these crops. Proper stocking rates, pasture rotation, and timely grazing help to maintain good tilth and plant density.

In a few areas this soil is used for trees. It is well suited to trees, but plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, depth to limestone, moderate shrink-swell potential, and moderate permeability.

This soil has severe limitations for building sites because of low strength of the clayey underlying material. Using properly designed foundations and footings helps to prevent structural damage from low strength of the soil.

This soil has severe limitations for local roads and streets. The base material needs to be strengthened with more suitable material.

This soil has severe limitations for septic tank absorption fields because of the depth to rock. Capability subclass IIs; woodland suitability subclass 2o.

NnA—Nineveh loam, 0 to 2 percent slopes. This nearly level, well drained soil is on terraces along the White River. It is moderately deep over sand and gravelly sand. The mapped areas are irregular in shape and range from 3 to 30 acres in size.

In a typical profile the surface layer is very dark grayish brown loam in the upper 8 inches and is dark brown, friable loam in the lower 4 inches. The subsoil is about 20 inches thick. It is brown, firm clay loam and gravelly clay loam. The underlying material, to a depth of 60 inches, is calcareous and is pale brown sand and gravelly sand. In places the surface layer is less than 10 inches thick. In some of the more sloping areas, the surface layer is gravelly loam and has many cobbles. In small areas the depth to loose sand and gravel is more than 40 inches.

Included with this soil in mapping are small areas of Sleeth soils in lower lying areas. Also included are small areas of soils that have slopes of more than 2 percent and small areas of Ross soils.

Permeability is moderate in the subsoil and very rapid in the underlying material. Available water capacity is moderate. Content of organic matter in the surface layer is high. Surface runoff in cultivated areas is slow. The surface layer of this soil is friable and is easy to till within a wide range of moisture content. This soil is droughty in dry periods.

This soil is well suited to corn, soybeans, and small grains, and in most areas it is used for these crops. Conservation practices, including minimum tillage and return of crop residue to the soil, help to maintain the content of organic matter and good tilth.

In a few areas this soil is used for hay and pasture crops. It is well suited to grasses and legumes. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is suited to trees. Because the soil formed under grass vegetation, however, there are few trees growing on it.

This soil is suitable for urban development. The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate permeability in the subsoil, and very rapid permeability in the underlying material.

This soil has moderate limitations for building sites. Using properly designed footings for dwellings and small buildings helps to prevent structural damage from shrinking and swelling and low strength of the soil.

This soil has severe limitations for local roads and streets because of low strength. The base material needs to be strengthened with suitable material.

This soil has slight limitations for septic tank absorption fields. Areas of this soil have potential as a source of sand and gravel. Capability subclass IIs; woodland suitability group 1o.

OcA—Ockley silt loam, 0 to 2 percent slopes. This nearly level, deep, well drained soil is mainly on broad terraces. It is also on small rises on uplands. Most of the mapped areas are elongated and are parallel to major streams. Some areas on uplands are irregular in shape. The mapped areas range from 3 to 250 acres in size.

In a typical profile the surface layer is dark yellowish brown silt loam about 10 inches thick. The subsoil is about 46 inches thick. The upper part of the subsoil is brown, friable loam; the next part is dark yellowish brown and brown, firm clay loam; the next part is dark yellowish brown, firm loam; and the lower part is dark reddish brown, firm gravelly sandy clay loam. The underlying material, to a depth of 70 inches, is stratified sand and gravelly sand. The depth to loose sand and gravel is as much as 80 inches in places. The combined thickness of the surface layer and the part of the subsoil that formed in silty material is as much as 30 inches in some places. In the east-central part of the county, many limestone fragments that are as much as 12 inches in diameter are in the soil. In some areas on uplands, the underlying material is sand and silt and the subsoil has little or no gravel. Thickness of the sand and gravel ranges from a few feet

along minor streams and on uplands to more than 50 feet along White River.

Included with this soil in mapping are a few small areas of Sleeth soils in lower positions, small areas of Fox soils, and small areas of soils that have slopes of more than 2 percent. Also included are areas of steep, shallow soils on breaks along major streams.

Permeability is moderate, and available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff is slow. The surface layer of this soil is friable and is easy to till within a fairly wide range of moisture content.

This soil is suited to corn, soybeans, and small grains, and in most areas it is used for these crops. Minimum tillage and returning crop residue to the soil help to maintain content of organic matter and good tilth.

In some areas this soil is used for hay and pasture crops. It is well suited to grasses and legumes. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good conditon.

This soil is suited to trees but is used for trees in only a few areas. The hazards and limitations in woodland management are slight, except plant competition is moderate. Competing vegetation can be controlled by cutting, spraying, or girdling.

This soil is suitable for urban development. Many areas are used for this purpose in the southern part of the county. The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate shrink-swell potential, moderate permeability in the subsoil, and very rapid permeability in the underlying material.

This soil has moderate limitations for building sites because of shrink-swell potential and low strength of the soil. Using properly designed foundations, footings, and basement walls and using drainage tile can help to prevent structural damage from low strength and shrinking and swelling of the soil.

Low strength is a severe limitation to the use of this soil for local roads and streets. The base material for roads needs to be strengthened with suitable material.

Many areas of this soil are used as a source of sand and gravel. Capability class I; woodland suitability subclass 1o.

OcB2—Ockley silt loam, 2 to 6 percent slopes, eroded. This gently sloping, deep, well drained soil is mostly on broad outwash terraces. It is also on small knobs on uplands. The mapped areas on terraces are mostly elongated and range from 3 to 40 acres in size. The mapped areas on uplands are irregular in shape and range from 3 to 15 acres in size. Slopes are short.

In a typical profile the surface layer is dark yellowish brown silt loam about 7 inches thick. The subsoil is about 39 inches thick. The upper part of the subsoil is dark yellowish brown and dark brown, firm clay loam; the next part is dark yellowish brown, firm loam; and the lower part is dark reddish brown, firm gravelly sandy clay loam. The substratum, to a depth of 60 inches, is sand and gravelly sand. In small areas on uplands, the substratum is stratified sand and silt and the subsoil has little or no gravel. In small areas along White River, the subsoil is sandy loam. In the east-central part of the county, many limestone fragments that are as much as 12 inches in diameter are in the soil. Thickness of the sand and gravel ranges from a few feet along minor streams and on uplands to more than 50 feet along White River.

Included with this soil in mapping are small areas of Fox, Miami, and Sleeth soils. Also included are severely eroded soils that have a surface layer of clay loam or gravelly clay loam and areas of steep, shallow soils on breaks.

Permeability is moderate, and available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff in cultivated areas is medium. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content.

This soil is suitable for corn, soybeans, and small grains, and in most areas it is used for these crops. Conservation practices are needed to control erosion and surface runoff in cultivated areas. Crop rotation, minimum tillage, contour farming, and the use of terraces, diversions, grassed waterways, and grade stabilization structures are practices that help to prevent erosion. Minimum tillage and the use of crop residue help to control erosion and to maintain tilth and the content of organic matter.

Some areas are used for hay and pasture crops. This soil is well suited to grasses and legumes. The growing of grasses and legumes helps to control erosion. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is well suited to trees, but it is used for trees in only a few areas. The hazards and limitations in woodland management are slight, except plant competition is moderate. Competing vegetation can be controlled by cutting, spraying, or girdling.

This soil is suitable for urban development. Many areas are used for this purpose in the southern part of the county. The main soil features that adversely affect engineering uses of this soil are moderate potential frost action, moderate shrink-swell potential, moderate permeability in the subsoil, and very rapid permeability in the underlying material.

This soil has moderate limitations for dwellings because of shrink-swell potential and low strength of the soil. Using properly designed foundations, footings, and basement walls and using drainage tile help to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has slight limitations for septic tank absorption fields. Many areas of this soil are used as a source of sand and gravel.

This soil has severe limitations for local roads and streets because of low strength of the soil. The base material of roads needs to be strengthened with suitable material. Capability subclass IIe; woodland suitability subclass 1o.

Or—Orthents. These nearly level to steep, deep, well drained soils are on uplands and terraces which have been changed by man. This map unit is near highway interchanges, shopping centers, gravel pits, and landfills. In some places, deep cuts were made in the original land surface and the soil material was used as fill in low-lying areas to make the surface smooth and level. In other places, the soil material was removed and was used as fill for highway grades, overpasses, and exit ramps. The mapped areas range from 3 to 30 acres in size.

In a typical area of fill, Orthents consist of a mixture of the surface layer, subsoil, and substratum of the original soil. The surface texture is silt loam, loam, or clay loam and generally contains gravel or stones. In a typical area where a deep cut has been made, Orthents consist mainly of loam or clay loam glacial till.

Included with these soils in mapping are small areas of steep soils that have short slopes, areas of sand and gravel, and bedrock outcrops. Muck underlies Orthents in a few fill areas. In many fill areas, the material is not soil but is rock, glass, metal, and other material. Also included are areas of poorly drained and somewhat poorly drained soils.

Permeability is moderate to very slow, and available water capacity is moderate. Content of organic matter in the surface material is low. Reaction is slightly acid to mildly alkaline.

Most areas of these soils are in permanent grass or in close-growing shrubs. Many areas are surrounded by heavily travelled highways. Special management practices are needed in areas of Orthents. An intensified fertility program emphasizing the incorporation of organic residue or manure is needed if these soils are used for crops. Conservation practices are needed to control erosion in sloping areas, and drainage may be needed in nearly level areas. Exposed areas should be revegetated as soon as possible after construction is completed. Diversions, box inlet structures, grade stabilization structures, and grassed waterways can be used to conserve the soil.

The main soil features that affect engineering uses of these soils are slope, moderate to high potential frost action, and moderate to very slow permeability. The hazard of erosion is severe during construction.

If these soils are used for building sites, onsite investigation is needed to determine soil properties and limitations. Depth to the water table and frost action potential should be considered in determining soil suitability. The soil material is quite variable, and engineering test data should be collected. The soil properties that affect design of structures vary within a short distance. Removal of vegetation should be kept to a minimum, and protective plant cover should be established as soon as possible to reduce soil losses through erosion. Other limitations that affect the suitability of these soils for building sites are soil wetness and permeability in nearly level areas and slope and permeability in gently sloping and moderately sloping areas. Capability class VIII; woodland suitability subclass 3o.

Pa—Palms muck. This nearly level, deep, very poorly drained soil is in depressions and drainageways on uplands and terraces. Runoff from higher adjacent soils is ponded on this soil. Most of the mapped areas are elongated or oval in shape. The mapped areas range from 2 to 40 acres in size.

In a typical profile the surface layer is black muck about 9 inches thick. Below this, to a depth of 29 inches, is black, friable muck. Below this, to a depth of 60 inches, the underlying material is gray and very dark gray stratified silty clay loam and clay loam. In some places the organic layer is less well decomposed, and in some places the underlying material is loamy sand or sandy loam.

Included with this soil in mapping are small areas of Houghton soils. Also included are Patton, Brookston, and Westland soils on the edge of depressions.

Permeability is moderately rapid in the organic material and moderate to moderately slow in the underlying mineral soil material. The water table is commonly at the surface or is at a depth of less than 1 foot in winter and spring. Available water capacity is high. Content of organic matter in the surface layer is very high. Surface runoff is ponded. The surface layer of this soil is friable and can be tilled within a wide range of moisture content.

In some areas, this soil is idle and the vegetation consists mainly of wetland weeds and brush.

This soil is suitable for crops, and in most areas it is adequately drained and is used for crops. Drainage is difficult to install, however, because of the lack of adequate outlets. Subsidence is commonly a problem after drainage has been installed. Small grains that are planted in fall and early in spring may be damaged by ponding of water, even if satisfactory drainage for row crops has been installed. Minimum tillage and the use of crop residue and cover crops help to prevent soil blowing and to maintain soil tilth. Soil blowing can be a problem when the soil is very dry.

This soil is well suited to grasses and legumes if it is adequately drained. Ponding may cause damage to grasses and legumes in winter and early in spring. The major problems in pasture management are overgrazing and grazing when the soil is wet. Proper stocking rates, timely grazing, and restricting grazing in wet periods will help to keep the pasture plants and soil in good condition.

This soil is not suited to trees, except water-tolerant species. Limitations and hazards in woodland management are severe, except the hazard of erosion is slight.

This soil is generally unsuitable for urban development. The main soil features that adversely affect engineering uses of this soil are high potential frost action, seasonal high water table, and poor stability of the organic material.

This soil has severe limitations for urban uses and sanitary facilities because of the high water table, ponding, and poor stability of the organic layer. If this soil is used for local roads and streets, the organic material needs to be replaced with suitable base material. Capability subclass IIw; woodland suitability subclass 4w.

Pn—Patton silty clay loam. This nearly level, deep, poorly drained soil is in broad depressions and drainageways on lake plains and terraces. Runoff from adjacent soils is ponded on this soil. The mapped areas are mostly oval in shape but some areas in drainageways are elongated. The areas range from 3 to 200 acres in size.

In a typical profile the surface layer is very dark gray and black silty clay loam about 12 inches thick. The subsoil is dark gray, olive gray, and light olive gray, mottled, firm silty clay loam about 26 inches thick. The substratum, to a depth of 60 inches, is calcareous and is olive gray and gray silt loam and light silty clay loam. In some areas, the surface layer is less than 12 inches thick or the substratum is stratified loamy material. In some areas, calcareous loam till is at a depth of less than 60 inches and part of the subsoil below a depth of 40 inches formed in glacial till. Many areas that are surrounded by eroded soils have an overwash of light colored soil material on the original surface layer.

Included with this soil in mapping are small areas of Brookston soils on slightly higher positions. Also included are small areas of Whitaker and Crosby soils on slight rises, soils that are similar to this Patton soil but have sand and gravelly sand below a depth of 50 inches, and small areas of soils in depressions that are wet for long periods.

Permeability is moderate. The water table is commonly at the surface or at a depth of less than 1 foot in winter and spring. Available water capacity is high. Content of organic matter in the surface layer is high. Surface runoff is ponded or is very slow. The surface layer is cloddy and difficult to work if the soil is tilled when it is too wet. This soil can be satisfactorily tilled only within a narrow range of moisture content. Fall plowing is beneficial if this soil is to be used for crops in spring.

This soil is suitable for crops. In most areas it is drained with subsurface tile and open ditches and is used for corn and soybeans. Surface drains are needed in most areas to remove surface water from low-lying pockets, because the subsoil restricts the downward movement of water to the tile. Small grains can be grown unless ponding is a problem in winter and early in spring. Wetness is the main limitation to the use of this soil for crops. Minimum tillage and the use of crop residue help to maintain tilth and to increase content of organic matter.

A few undrained areas are used for pasture. This soil is suited to grasses and legumes, but ponding may cause damage to the plants in winter and early in spring. The major problem in pasture management is overgrazing and grazing when the soil is wet. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely grazing, and restricted grazing in wet periods help to keep the pasture plants and soil in good condition.

Water-tolerant species of trees grow well on this soil, and a few undrained areas are used for trees. The equipment limitation and plant competition are severe. Seedling mortality and the hazard of windthrow are moderate. Water-tolerant species grow best on this soil. Competing vegetation can be controlled by cutting, spraying, and girdling.

This soil is poorly suited to urban development. The soil features that adversely affect engineering uses of this soil are a seasonal high water table, moderate shrink-swell potential, high potential frost action, and moderate permeability.

This soil has severe limitations for building sites because of a seasonal high water table and ponding. The sites need to be artificially drained and protected from flooding. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets because of the seasonal high water table and high potential frost action. Drainage ditches need to be installed along roads to lower the water table and to help prevent damage from frost action. The base material should be replaced or strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of a seasonal high water table. Sanitary facilities should be connected to sewers and treatment facilities. Capability subclass IIw; woodland suitability subclass 2w.

Ps—Patton silty clay loam, limestone substratum. This nearly level, deep, poorly drained soil is in depressions on terraces and old sluiceways. Runoff from higher adjacent soils is ponded on this soil. Most of the mapped areas are irregular in shape and some are elongated and are parallel to major streams. The mapped areas range from 3 to 120 acres in size.

In a typical profile the surface layer is black silty clay loam about 13 inches thick. The subsoil is dark gray, mottled, firm silty clay loam about 24 inches thick. The substratum, to a depth of about 52 inches, is calcareous and is gray, mottled silt loam. Hard limestone is at a depth of 52 inches. The substratum in some places is silty clay loam, loam, sand, or gravelly sand. In some areas the subsoil extends to the limestone.

Included with this soil in mapping are small areas of Sloan, Patton, and Westland soils. Also included are small areas of Randolph Variant soils on slight rises and areas of soils that are less than 40 inches deep to limestone.

Permeability is moderate. Available water capacity is high. Content of organic matter in the surface layer is high. Surface runoff is very slow or is ponded. The water table is commonly at the surface or at a depth of less than 1 foot in winter and early in spring. The surface layer of this soil is firm and can be tilled only within a narrow range of moisture content. The surface layer is cloddy and difficult to work if the soil is tilled when it is too wet.

This soil is suitable for crops. In most areas it is drained with subsurface tile and open ditches and is used

for corn, soybeans, and wheat. In many areas surface drains are needed to remove surface water from low-lying pockets because the subsoil restricts the downward movement of water to the tile. In drained areas, this soil is well suited to corn and soybeans. Small grains can be grown unless ponding is a problem in winter and early in spring. Wetness is the main limitation to the use of this soil for crops. Minimum tillage and the use of crop residue help to improve and maintain tilth and to increase content of organic matter.

In a few areas this soil is used for hay and pasture crops. It is suited to grasses and legumes for hay and pasture, but artificial drainage is needed to obtain optimum production. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely grazing, and restricting grazing in wet periods help to reduce surface compaction and to maintain good tilth and plant density.

This soil is suited to trees, and in a few areas it is used for trees. However, the equipment limitations, plant competition, seedling mortality, and hazard of windthrow are severe. The hazard of erosion is slight. Water-tolerant species grow best. Seedlings survive and grow well if competing vegetation is controlled.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, depth to limestone, moderate shrink-swell potential, and moderate permeability.

This soil has severe limitations for building sites because of a seasonal high water table and ponding. The sites need to be artificially drained and protected from flooding. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil. Where excavation is necessary, the depth to limestone is a moderate limitation.

This soil has severe limitations for local roads and streets because of the seasonal high water table and high potential frost action. The base material should be replaced or strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of a seasonal high water table. Sanitary facilities should be connected to sewers and treatment facilities. Capability subclass IIw; woodland suitability subclass 2w.

Pt—Pits. This map unit is nearly level to steep and is well drained. It consists of gravel pits and a limestone quarry. Small gravel pits are on uplands, terraces, and bottoms, and large gravel pits are on terraces. The gravel pits range from 1 to more than 100 acres in size. The limestone quarry is on uplands in the east-central part of the county. It is about 80 acres in size. In one large gravel pit in the southern part of the county, sand and gravel have been excavated down to the limestone bedrock; the limestone is now quarried for commerical purposes.

In a typical area, the soil material has been removed and sand, gravel, or limestone is exposed. In places soil material has washed into the pits and supports a sparse cover of vegetation.

Included with this unit in mapping are small areas where the overburden has been piled; these areas have a cover of vegetation. Also included are small, abandoned pits on uplands; all the gravel has been removed, and the glacial till is exposed. Also included are many areas where water covers the lowest part of the pits.

Permeability of the material ranges from very rapid in the gravel pits to very slow in the limestone quarry. Available water capacity is very low. Content of organic matter is low. Reaction ranges from slightly acid to moderately alkaline. Most of the exposed sand, gravel, and limestone is calcareous.

Most areas of this map unit are barren. Many gravel pits and the limestone quarry are in operation.

Erosion is a hazard on this unit, but the use of conservation practices is limited by the abrupt topography in many of the areas.

The soil features that affect engineering uses of this map unit are slope and, in many areas, a high water table. If this map unit is used as a building site, onsite investigation is needed. These soil properties are quite variable, and engineering test data should be collected. The soil properties that affect design of structures vary within a short distance. Capability class VIII.

Ra—Randolph Variant silt loam. This nearly level, deep, somewhat poorly drained soil is on level terraces. Most of the mapped areas are elongated and are parallel to streams. The mapped areas range from 3 to 50 acres in size.

In a typical profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam 4 inches thick. The subsoil is about 28 inches thick. The upper part of the subsoil is yellowish brown, mottled, friable clay loam; the next part is dark yellowish brown, mottled, firm clay loam; and the lower part is light olive brown, mottled, firm silty clay loam. Soft gray limestone is at a depth of about 41 inches. Hard limestone is at a depth of 44 inches. In some areas hard limestone is at a depth of less than 40 inches. Cobbles are on the surface in a few areas.

Included with this soil in mapping are small areas of Milton Variant soils on slightly higher rises and areas of Patton soils in depressions and along drainageways. Also included are some areas of Sleeth soils.

Permeability is moderately slow. Available water capacity is moderate. Content of organic matter in the surface layer is moderate. Surface runoff is slow. The water table is commonly at a depth of 1 to 3 feet in winter and early in spring. The surface layer of this soil is friable and can be tilled within a fairly wide range of moisture content. In some areas, excavation and artificial drainage are difficult because of the depth to limestone.

Most areas of this soil are artificially drained and used for corn, soybeans, and wheat. Wetness and depth to

bedrock are the main limitations to the use of this soil for crops. Conservation practices, including return of crop residue to the soil and minimum tillage, help to improve and maintain tilth and content of organic matter.

In a few areas this soil is used for hay and pasture crops. It is suited to grasses and legumes for hay or pasture but is not well suited to deep-rooted legumes because of the depth to limestone. Drainage is needed to obtain optimum production. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, timely grazing, and restricting grazing in wet periods help to reduce surface compaction and to maintain good tilth and plant density.

This soil is suited to trees, and a few areas are used for trees. Water-tolerant species grow best. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, depth to limestone, high shrink-swell potential, and moderately slow permeability.

This soil has severe limitations for building sites. The sites need to be artificially drained to prevent wetness from becoming a problem. Dwellings and small buildings with basements generally should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets because of low strength, wetness, and frost action. The base material for roads should be strengthened with suitable material.

Moderately slow permeability, depth to bedrock, and wetness are severe limitations to the use of this soil for septic tank absorption fields. Installing a large filter field and lowering the water table help to offset soil wetness, but generally a more suitable site should be selected. Several areas of this soil are used as a source of sand and gravel. Capability subclass IIIw; woodland suitability subclass 3o.

Ro—Ross loam. This nearly level, deep, well drained soil is on broad flood plains along White River. It is subject to occasional flooding. The mapped areas are elongated and are parallel to White River. They range from 3 to 100 acres in size.

In a typical profile the upper 14 inches of the surface layer is very dark grayish brown loam, the next 14 inches is black silt loam, and the lower 6 inches is dark brown loam. The underlying material is brown loam to a depth of 53 inches and is dark yellowish brown sandy clay loam to a depth of 60 inches. In some areas the depth to sand and gravelly sand is as little as 40 inches. The surface layer is as thin as 12 inches in some places.

Included with this soil in mapping are small areas of Genesee soils. Also included are slightly lower lying areas of Shoals soils.

Permeability is moderate. Available water capacity is high. Content of organic matter in the surface layer is high. Surface runoff in cultivated areas is slow. The surface layer of this soil is friable and is easy to till within a wide range of moisture content.

This soil is suitable for corn, soybeans, and small grains if it is protected from flooding. In most areas it is protected by levees and is used for crops. Flooding is the major hazard. Minimum tillage and the use of crop residue and cover crops help to maintain content of organic matter and good tilth.

This soil is well suited to grasses and deep-rooted legumes, for example, alfalfa. However, the plants may be damaged by floodwater. Proper stocking rates, pasture rotation, and timely grazing help to keep the soil in good condition.

This soil is well suited to trees, but very few trees are growing on it. Plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, spraying, or girdling.

This soil is generally unsuitable for urban development. The main soil features that adversely affect engineering uses of this soil are moderate permeability and moderate potential frost action. This soil is also subject to occasional flooding.

This soil has severe limitations for building sites and sanitary facilities because of flooding. Capability class IIw; woodland suitability subclass 1o.

Sh—Shoals silt loam. This nearly level, deep, somewhat poorly drained soil is on flood plains. It is subject to frequent flooding. The mapped areas are mostly elongated and are parallel to streams. Many areas are in narrow valleys along small streams. The mapped areas range from 3 to 100 acres in size.

In a typical profile the surface layer is dark grayish brown silt loam about 11 inches thick. The underlying material, to a depth of 39 inches, is dark grayish brown and grayish brown, mottled silt loam and loam. Below this, to a depth of 56 inches, it is gray and very dark gray sandy loam and sandy clay loam. Below this, to a depth of 60 inches, it is grayish brown fine gravel and coarse sand. In small areas scattered throughout the county, this soil has a darker surface layer; in some of these areas it is near Ross soils. In some places the underlying material has more gravel. This soil has carbonates throughout the profile in some areas. In some small areas in the upper reaches of small streams, this soil has firm loam till at a depth of 45 to 60 inches. In some small areas it has less clay and more sand between a depth of 10 and 40 inches. In some areas sand and gravelly sand are at a depth of only 40 inches.

Included with this soil in mapping are small areas of Genesee soils and small areas of Sloan soils in slight depressions.

Permeability is moderate. Available water capacity is high. Content of organic matter in the surface layer is moderate. The water table is commonly at a depth of 1 to 3 feet in winter and spring. Surface runoff is slow. The

surface layer of this soil is friable and is easy to till within a wide range of moisture content.

In most areas this soil is used for corn and soybeans. It is suited to corn, soybeans, and small grains if it is adequately drained. Wetness is the major limitation, and flooding is the major hazard. Most cropped areas are drained with subsurface tile. Minimum tillage and the proper use of crop residue help to maintain and increase content of organic matter and to maintain good tilth.

In many areas this soil is drained with subsurface tile and used for hay and pasture. It is suited to grasses and legumes, but adequate drainage is needed to obtain optimum production. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely grazing, and restricting grazing in wet periods help to keep the soil in good condition.

This soil is suited to trees. Several areas are used for trees, but these areas are small and inaccessible or are dissected in places by overflow channels. Plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled.

This soil is generally unsuitable for urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table and high potential frost action. This soil is also subject to frequent flooding.

This soil has severe limitations for building sites and sanitary facilities because of a seasonal high water table and flooding. Capability subclass IIw; woodland suitability subclass 2o.

St—Sleeth loam. This nearly level, deep, somewhat poorly drained soil is in slight depressions on broad terraces and along drainageways. The mapped areas are mostly elongated and are parallel to streams. Areas of this soil range from 3 to 40 acres in size.

In a typical profile the surface layer is dark grayish brown loam about 11 inches thick. The subsoil is about 36 inches thick. The upper part of the subsoil is grayish brown, mottled, friable loam; the next part is light brownish gray, mottled, firm clay loam; the next part is yellowish brown, mottled, firm sandy clay loam; and the lower part is dark gray, friable sandy clay loam. The substratum, to a depth of 60 inches, is dark gray and light brownish gray coarse sand and fine gravelly sand. Where this soil is near Nineveh soils, it commonly has a darker surface layer as much as 10 inches thick. Along some small streams, the substratum is thinner and firm glacial till is at a depth of less than 5 feet. In some places the substratum is mostly gravel. In some areas the substratum is stratified sand and silt.

Included with this soil in mapping are small areas of Fox, Ockley, and Nineveh soils in slightly elevated positions. Also included are small areas of Westland soils in deeper depressions.

Permeability is moderate. The water table is commonly at a depth of 1 to 3 feet in winter and early in spring. Available water capacity is high. Content of organic matter in the surface layer is moderate. Surface runoff is slow. The surface layer of this soil is friable and is easy to till within a fairly wide range of moisture content.

In almost all areas this soil is used for corn, soybeans, and small grains. It is suited to these crops if drainage has been installed. Most areas in cropland are drained with subsurface tile and open ditches. Wetness is the major limitation in use and management. Minimum tillage, and the use of crop residue and cover crops help to maintain content of organic matter and good tilth.

In a few areas this soil is used for hay and pasture crops. It is suited to grasses and legumes if it is adequately drained. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is suited to trees, but it is used for trees only in a few undrained areas. Plant competition is moderate. Competing vegetation can be controlled by cutting, spraying, or girdling.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, moderate permeability in the subsoil, and rapid permeability in the substratum.

This soil has severe limitations for building sites. The sites need to be artificially drained to prevent wetness from becoming a problem. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets. Installing ditches along roads helps to lower the water table and to prevent damage from frost action. The base material for roads needs to be strengthened or replaced with suitable material.

Wetness is a severe limitation to the use of this soil for septic tank absorption fields. Sanitary facilities should be connected to sewers and treatment facilities. If treatment facilities are not available, however, installing a large filter field and lowering the water table help to offset soil wetness. Several areas of this soil are used as a source of sand and gravel. Capability subclass IIw; woodland suitability subclass 3o.

Sx—Sloan silty clay loam, sandy substratum. This nearly level, deep, very poorly drained soil is in slight depressions on flood plains and is subject to frequent flooding. Some areas of this soil are ponded much of the time. Most of the mapped areas are elongated. The areas range from 3 to 40 acres in size.

In a typical profile the upper 8 inches of the surface layer is very dark grayish brown silty clay loam, and the lower 5 inches is very dark grayish brown, mottled clay loam. The subsoil is dark gray, mottled, firm clay loam about 21 inches thick. The underlying material is gray, stratified loam and sandy loam to a depth of 40 inches and gray coarse sand and gravelly sand to a depth of 60 inches. In small areas, light colored soil material has

washed over the original surface layer. In places the subsoil has layers of sandy clay loam or sandy loam.

Included with this soil in mapping are small areas of Shoals soils on slight rises. Also included are small areas of Patton and Westland soils.

Permeability is moderate. The water table is at the surface or is at a depth of less than 6 inches in winter and spring. Available water capacity is moderate. The content of organic matter in the surface layer is high. The surface layer is cloddy and difficult to work if the soil is tilled when it is too wet.

In most areas this soil is drained with subsurface tile and open ditches and used for corn and soybeans. It is well suited to these crops if it is adequately drained. Wetness is the major limitation, and flooding is a major hazard. Small grains that are planted in fall and early in spring can be damaged by ponded water or floodwater in winter and early in spring, even if satisfactory drainage has been installed for row crops. Minimum tillage and the use of crop residue and cover crops help to maintain content of organic matter and good tilth.

A few areas of this soil are used for hay and pasture crops. However, grasses and legumes do not grow well unless adequate drainage is installed. Ponding is a hazard in winter and early in spring. The major problem in pasture management is overgrazing and grazing when the soil is wet. Proper stocking rates, timely grazing, and restricting grazing in wet periods help to keep the pasture plants and soil in good condition.

Water-tolerant species of trees grow well on this soil; in a few areas the soil is undrained, and the vegetation consists mainly of water-tolerant species of weeds and trees. The hazards and limitations in woodland management are severe, except the hazard of erosion is slight. Seedlings survive and grow well if competing vegetation is controlled.

This soil is generally unsuitable for urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, and moderate permeability. Also, this soil is subject to frequent flooding.

This soil has severe limitations for building sites and sanitary facilities because of a high water table and the hazard of flooding. Capability subclass IIIw; woodland suitability subclass 2w.

We—Westland silty clay loam. This nearly level, deep, very poorly drained soil is in depressions, swales, and narrow drainageways on outwash plains. Runoff from higher adjacent soils is ponded on this soil. The mapped areas are mostly elongated and are parallel to streams. The areas range from 3 to 200 acres in size.

In a typical profile the upper 9 inches of the surface layer is very dark gray silty clay loam, and the lower 7 inches is very dark gray, mottled silty clay loam. The subsoil is about 30 inches thick. The upper part of the subsoil is dark gray, mottled, firm clay loam and the lower part is gray, mottled, firm and friable gravelly clay loam and gravelly sandy loam. The underlying material, to a depth of 60 inches, is calcareous and is gray sand and gravelly sand. In some places the upper part of the subsoil is silty clay loam as much as 24 inches thick. In places, lighter colored soil material has washed over the original surface layer. In a few areas the surface layer is mucky silt loam. In some areas the underlying material is sand and silt. Thickness of the sand and gravel ranges from a few feet to more than 50 feet along White River.

Included with this soil in mapping are areas of Patton soils and areas of Sleeth and Whitaker soils on slight rises. In small areas in the southern part of the county, soils that have a high iron content and many hard iron concretions on the surface are also included. Small areas of soils that are wet for long periods are also included.

Permeability is slow. The water table is commonly at the surface or is at a depth of less than 1 foot in winter and early in spring. Available water capacity is high. Content of organic matter in the surface layer is high. Surface runoff is ponded or is very slow. The surface layer is cloddy and difficult to work if the soil is tilled when it is too wet. Fall plowing helps to make tillage of this soil easier in spring.

If this soil is adequately drained, it is suited to corn, soybeans, and small grains. In most areas it is drained and is used for corn and soybeans. Drainage consists of subsurface tile, surface drains, or open ditches, or some combination of these. Wetness is the major limitation to the use of this soil. Minimum tillage and the proper use of crop residue help to improve and maintain tilth and to increase content of organic matter.

This soil is suited to grasses and legumes for hay and pasture, and a few areas are used for these crops. Drainage is necessary to obtain optimum production. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, timely grazing, and restricting grazing in wet periods help to reduce compaction and to maintain tilth and plant density.

This soil is suited to trees, and a few areas are used for trees. The equipment limitation, plant competition, seedling mortality, and hazard of windthrow are severe.

The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, moderate shrink-swell potential, and slow permeability.

This soil has severe limitations for building sites because of a seasonal high water table. The sites need to be artificially drained and protected from flooding. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from low strength and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets because of a seasonal high water table and high potential frost action. Installation of drainage ditches along roads helps to lower the water table and to prevent damage from frost action. The base material for roads needs to be replaced or strengthened with suitable material.

This soil has severe limitations for septic tank absorption fields because of a seasonal high water table and flooding. Sanitary facilities should be connected to sewers and treatment facilities. Capability subclass IIw; woodland suitability subclass 2w.

Wh—Whitaker loam. This nearly level, deep, somewhat poorly drained soil is on low stream terraces and lakebeds on uplands. The mapped areas are mostly irregular in shape, but many areas are oval shaped. The areas range from 3 to 30 acres in size.

In a typical profile the surface layer is dark grayish brown loam about 9 inches thick. The subsurface layer is light brownish gray, mottled loam about 4 inches thick. The subsoil is about 36 inches thick. The upper part is light brownish gray, mottled, friable clay loam and sandy clay loam; the next part is dark yellowish brown, mottled, firm clay loam and sandy clay loam; and the lower part is yellowish brown and grayish brown, friable, stratified fine sandy loam and loamy fine sand and has thin layers of clay. The substratum, to a depth of 60 inches, is yellowish brown, grayish brown, and light brownish gray, stratified very fine sand, fine sand, and silt loam. In many areas the subsoil is silty clay loam. In many areas on uplands the substratum is thinner and loam till is at a depth of less than 60 inches.

Included with this soil in mapping are small areas of Sleeth soils. Also included are small areas of soils that have texture similar to this Whitaker soil but have a brown subsoil that is free of mottles. Small areas of Patton and Brookston soils in depressions and a few small areas of severely eroded soils are also included.

Permeability is moderate. Available water capacity is high. The water table is commonly at a depth of 1 to 3 feet in winter and early in spring. Surface runoff is slow. Content of organic matter in the surface layer is moderate. The surface layer of this soil is friable and easy to till within a fairly wide range of moisture content.

This soil is suitable for corn, soybeans, and small grains. In most areas it is drained with subsurface tile and open ditches and is used for these crops. Minimum tillage and the use of crop residue and cover crops are practices that help to maintain content of organic matter and good tilth.

This soil is well suited to grasses and legumes for hay and pasture if it is adequately drained, and a few areas are used for these crops. The major problem in pasture management is overgrazing or grazing when the soil is wet. Grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, and timely grazing help to keep the pasture plants and soil in good condition.

This soil is suited to trees, but it is used for trees in only a few areas. Plant competition is moderate. Seedlings survive and grow well if competing vegetation is controlled by cutting, girdling, or spraying.

This soil is poorly suited to urban development. The main soil features that adversely affect engineering uses of this soil are a seasonal high water table, high potential frost action, and moderate permeability.

This soil has severe limitations for building sites. The sites need to be artificially drained to prevent wetness from becoming a problem. Dwellings and small buildings with basements should not be constructed on this soil. Using properly designed foundations and footings helps to prevent structural damage from frost action and shrinking and swelling of the soil.

This soil has severe limitations for local roads and streets. Installation of ditches along roads helps to lower the water table and to prevent damage from frost action. The base material for roads needs to be strengthened or replaced with suitable material.

Wetness is a severe limitation to the use of this soil for septic tank absorption fields. Sanitary facilities should be connected to sewers and treatment facilities. If treatment facilities are not available, however, installing a large filter field and lowering the water table help to offset soil wetness. Several areas of this soil are used as a source of sand and gravel. Capability subclass IIw; woodland suitability subclass 3o.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops, pasture, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should

maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

TOM SCHELLENBERGER, district conservationist, Soil Conservation Service, helped to prepare this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 195,227 acres in the survey area was used for crops and pasture in 1967 (*3*). Of this total, 15,446 acres was used for permanent pasture; 117,055 acres for row crops, mainly corn; 21,435 acres for close-growing crops, mainly wheat and oats; and 30,187 acres for rotation hay and pasture. The rest was idle cropland that was used for conservation purposes.

The potential of the soil is fair for increased production of food. Of soils that have good potential for cropland, about 11,348 acres is currently used for woodland and about 10,526 acres is used for pasture (*3*). Food production can also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can help in applying such technology.

Acreage in crops and pasture has gradually decreased as urban development has expanded. In 1967 about 24,826 acres was used for urban development in the county. This figure has increased at the rate of about 1,000 acres per year (*3*). Using this survey to help make land use decisions that will influence the future role of farming in the county is discussed in the section "General soil map for broad land use planning."

Soil drainage is the major problem on about 60 percent of the cropland and pastureland in Hamilton County. Artificial drainage on most of the very poorly drained soils, for example, Brookston, Westland, Palms, and Sloan soils, and on the poorly drained Patton soils is adequate for crops. However, a few areas of very poorly drained soils are in depressions and cannot be economically drained; drainage ditches would have to be deep and would have to extend for a great distance to a suitable outlet. For example, very few areas of Houghton soils are adequately drained.

Unless artificially drained, the somewhat poorly drained soils are so wet that crops are damaged in most years. Crosby, Whitaker, Sleeth, Shoals, and Randolph Variant soils, which make up about 102,813 acres in the county, are examples.

Miami soils and Milton Variant soils are naturally well drained, but they tend to dry slowly after rains. Small areas of wetter soils along drainageways and in swales are commonly included in mapping with these soils, especially where slopes are 2 to 6 percent. Artificial drainage is needed in some of these wetter areas.

The design of surface and subsurface drainage systems depends on the kind of soil. A combination of surface and tile drainage is needed in most areas of the poorly drained and very poorly drained soils that are used intensively for row crops. Drains need to be more closely spaced in soils that have slow permeability than in soils that have more rapid permeability. Adequate outlets for tile drainage are difficult to locate in many areas of Patton, Palms, Houghton, and Sloan soils.

Organic soils oxidize and subside when the pore space is filled with air; therefore, special drainage systems are needed to control the depth and the period of drainage. Regulating the water table to keep it at the level required by crops during the growing season and to raise it to the surface during the rest of the year minimizes oxidation and subsidence of organic soils. Information on drainage design for each kind of soil is given in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil erosion is the major problem on about 15 percent of the cropland and pastureland in Hamilton County (*3*). Erosion is a hazard in areas where the slope is more than 2 percent. Erosion is damaging because it reduces productivity and increases sedimentation in streams.

Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, for example, Crosby soils and Milton and Randolph Variant soils, and on soils that have a layer in or below the subsoil that limits the depth of the root zone. An example is Milton Variant soils, in which the root zone is limited by depth to bedrock. Erosion also reduces productivity of soils that tend to be droughty, for example, Fox and Nineveh soils.

Soil erosion results in an increase in the amount of sediment entering streams. Control of erosion minimizes

the pollution of streams by sediment and improves water quality for municipal use and recreational purposes and for fish and wildlife.

In many sloping areas, preparing a good seedbed and tilling are difficult in spots of clayey soils or of soils that have a hardpan because the original friable surface soil has been eroded. Such spots are common in areas of eroded Miami and Fox soils.

Erosion control practices provide for a protective surface cover, reduce runoff, and increase water infiltration. A cropping system that maintains a vegetative cover for extended periods can hold losses of soil from erosion to an amount that will not result in reduced productive capacity of the soil. On livestock farms, the legume and grass forage crops in the cropping system reduce erosion on sloping land; they also provide nitrogen and improve soil tilth for the succeeding crop.

Slopes are so short and irregular on sloping soils in Hamilton County that contour tillage or terracing is not practical. On these soils, a cropping system that includes a dense cover crop is required to control erosion unless minimum tillage is practiced. Minimizing tillage and leaving crop residue on the surface help to increase water infiltration and reduce runoff and erosion. These practices can be used successfully on most of the soils in the survey area, but they are more difficult to use on eroded soils and on soils that have a clayey surface layer, for example, Patton and Brookston soils. No-tillage of corn, which is increasingly common, helps to reduce erosion on sloping land and can be used on most of the soils in the survey area. However, it is more difficult to use successfully on soils that have a clayey surface layer.

Diversions and parallel tile outlet terraces are used to shorten the slopes and help to reduce sheet, rill, and gully erosion. Their use is most practical on deep, well drained soils that are highly susceptible to erosion. Terracing reduces soil losses from erosion and the associated loss of fertilizer elements and reduces damage to crops and water courses from sedimentation. It also reduces the need for grassed waterways, which occupy productive land that can be used for row crops. Terracing also facilitates contour farming, which reduces the use of fuel and the amount of pesticides entering water courses. Most of the Miami soils are suitable for terraces. Soils that have bedrock at a depth of less than 40 inches and soils that have a heavy textured, clayey subsoil are less suitable for terraces and diversions.

Grassed waterways are needed in many areas of Hamilton County on sloping soils, for example, Miami and Fox soils. Also, many areas of Crosby and Brookston soils should have waterways in places where a large watershed drains across these soils. Tile drainage is generally needed beneath waterways that are installed on Crosby and Brookston soils and is also needed in many areas of the Miami soils where seepage occurs along drainageways.

Many grade stabilization structures are needed in the county because of the large number of open ditches. These structures help reduce erosion where runoff drains into an open ditch (fig. 10). These structures also are commonly needed in open ditches where excessive gradient results in erosion of the sides and bottom of the ditches.

Soil blowing is a hazard on Houghton and Palms soils if they are drained. It can damage these muck soils in only a few hours if the wind is strong and if the soils are dry and are bare of vegetation or surface mulch. Maintaining a vegetative cover, using a surface mulch, or rough tillage of surface layer minimizes soil blowing on these soils. Windbreaks of adapted shrubs can be used to reduce soil blowing on the muck soils. Soil blowing also occurs on the dark colored mineral soils if they are bare of vegetation. Soils that are plowed in fall are highly susceptible to soil blowing in spring.

Soil fertility is naturally low or moderate in most of the soils on uplands and terraces in the survey area. The soils on flood plains, for example, Ross, Genesee, and Shoals soils, are neutral or mildly alkaline and are naturally higher in content of plant nutrients than most of the soils on uplands and terraces. Very poorly drained soils, for example, Brookston, Westland, Sloan, Houghton, and Palms soils, and poorly drained Patton soils are in depressions and receive runoff from adjacent soils on uplands. These soils are naturally slightly acid or neutral.

Most of the soils on uplands and terraces are naturally strongly acid or medium acid. These soils generally require application of ground limestone for good growth of alfalfa and other crops that grow only on nearly neutral soils. The content of available phosphorus and potash is naturally low in most of these soils. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop to be grown, and on the expected level of yields. The Cooperative Extension Service can help to determine the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Many of the soils that are used for crops in the survey area have a silt loam surface layer that is dark in color and has a moderate content of organic matter. These soils generally have moderate to weak structures, and intense rainfall causes some crust to form on the surface. In some areas the crust is hard when dry and is impervious to water. When a hard crust forms, infiltration is reduced and runoff is increased. Regular additions of crop residue, manure, and other organic material can help to improve soil structure and to reduce crusting.

Fall plowing is generally not a good practice on light colored soils that have a silt loam surface layer because a crust forms during winter and spring. Many of the soils are nearly as dense and hard at planting time as before fall plowing. About 19 percent of the cropland in the county consists of sloping soils that are subject to damaging erosion if they are plowed in fall.

The dark colored Brookston, Patton, Westland, and Sloan soils are clayey, and poor soil tilth is a problem

because in many years these soils are wet until late in spring. If plowed when wet, these soils generally are very cloddy when dry and cause difficulty in seedbed preparation. Fall plowing on these soils generally results in good tilth in spring.

Field crops that can be grown on the soils in the survey area include many that are not now commonly grown. Corn and soybeans are the main row crops.

Wheat and oats are the common close-growing crops. Rye can be grown, and bromegrass, fescue, redtop, and bluegrass can be grown for seed.

Special crops are of limited commercial importance in the survey area. Only a small acreage is used for vegetables and small fruits. Deep soils that have good natural drainage and that warm early in spring are especially well suited to many vegetables and small fruits. These are the Ockley, Fox, and Nineveh soils that have slopes of less than 6 percent. These soils cover about 12,658 acres. Fox and Nineveh soils need irrigation for optimum production. Crops can generally be planted and harvested earlier on all of these soils than on the other soils in the survey area.

If adequately drained, the muck soils in the county are well suited to a wide variety of vegetable crops. Houghton and Palms muck soils cover about 538 acres in the survey area.

Most of the well drained soils in the survey area are suitable for orchards and nursery plants. Soils in low positions, where frost is frequent and air drainage is poor, generally are poorly suited to early vegetables, small fruits, and orchards.

Latest information and suggestions for growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop, or the crop is not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each map unit in the section "Soil maps for detailed planning."

Woodland management and productivity

MITCHELL G. HASSLER, forester, Soil Conservation Service, assisted in the preparation of this section.

Table 6 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Map unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *w* indicates excessive water in or on the soil, and *r* indicates steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: w and r.

In table 6 the soils are also rated for a number of factors to be considered in management. *Slight*, *moderate*, and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds (fig. 11).

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of

the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

MAX L. EVANS, state conservation engineer, Soil Conservation Service, assisted in the preparation of this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special

planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very

high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 11 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facili-

ties and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

JAMES D. MCCALL, wildlife biologist, Soil Conservation Service, assisted in the preparation of this section.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, sorghum, wheat, oats, barley, millet, buckwheat, soybeans, and sunflowers.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluegrass, switchgrass, lespedeza, bromegrass, timothy, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are ragweed, bristlegrass, panicgrass, bluegrass, goldenrod, beggarweed, pokeweed, lambsquarter, partridgepea, knotweed, and lespedeza.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, poplar, beech, maple, wild cherry, blackgum, sweetgum, hawthorn, basswood, dogwood, sumac, hickory, hazelnut, black walnut, blackhaw, viburnum, and briers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are dogwood, autumn-olive, viburnum, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, hemlock, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, arrowhead, cattail, buttonbush, redosier dogwood, willow, and swamp rose and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include woodcock, thrushes, nuthatch, vireos, woodpeckers, tree squirrels, gray fox, raccoon, and white-tailed deer.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, rails, kingfishers, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index,

liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snowmelts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*4*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Brookston series

The Brookston series consists of deep, very poorly drained, moderately permeable soils on glacial till plains. These soils formed in loamy sediment and in the underlying, loamy glacial till. Slopes range from 0 to 2 percent.

Brookston soils are near Crosby and Patton soils in many areas. Crosby soils are better drained and are in a higher position than Brookston soils. Patton soils have less sand in the solum than Brookston soils and have a C horizon of stratified silt and clay.

Typical pedon of Brookston silty clay loam, in a cultivated field 1,100 feet east and 2,220 feet north of the southwest corner of sec. 7, T. 18 N., R. 3 E.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate coarse granular structure; firm; many fine roots; slightly acid; abrupt smooth boundary.

A12—7 to 11 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine subangular blocky structure; firm; common fine roots; common very fine pores; common continuous distinct thin black (10YR 2/1) organic films on faces of peds; slightly acid; abrupt smooth boundary.

B21t—11 to 19 inches; dark gray (10YR 4/1) clay loam; many medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine and medium angular and subangular blocky structure; firm; common fine roots; common very fine pores; many continuous medium very dark gray (5Y 3/1) clay films on faces of all peds and in voids; 2 percent gravel; neutral; clear smooth boundary.

B22t—19 to 29 inches; grayish brown (10YR 5/2) clay loam; many fine and medium distinct and yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to strong fine and medium granular blocky; firm; common fine roots; many fine pores; common continuous distinct thin dark gray (10YR 4/1) and gray (10YR 5/1) clay films on faces of peds and in channels; 3 percent gravel; neutral; clear smooth boundary.

B23t—29 to 49 inches; gray (10YR 5/1) clay loam; many medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; common fine and very fine roots; common fine pores; few continuous distinct thin dark gray (10YR 4/1) clay films along root channels and on faces of peds; 5 percent gravel; neutral; clear smooth boundary.

B3t—49 to 58 inches; grayish brown (10YR 5/2) loam; common medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium subangular blocky structure; firm; few continuous thin dark gray (10YR 4/1) clay films in root channels; 5 percent gravel; neutral; abrupt smooth boundary.

C—58 to 70 inches; brown (10YR 5/3) loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; 10 percent gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 40 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is 10 to 18 inches thick and is silty clay loam or clay loam. Reaction is neutral or slightly acid. The B horizon has hue of 2.5Y, 5Y, or 10YR, value of 4 to 6, and chroma of 1 or 2. It commonly contains many mottles. The upper part of the B horizon is silty clay loam or clay loam. The lower part of the B horizon is clay loam, loam, or sandy clay loam and contains as much as 10 percent gravel. Reaction is neutral or mildly alkaline.

Crosby series

The Crosby series consists of deep, somewhat poorly drained, slowly permeable soils on glacial till plains. These soils formed in less than 20 inches of loess and in the underlying, loamy glacial till. Slopes range from 0 to 3 percent.

Crosby soils are similar to Whitaker soils and commonly are adjacent to Brookston and Miami soils. Whitaker soils have less clay in the B horizon than Crosby soils and have a C horizon of stratified silt loam and loam. Brookston soils have a finer textured A horizon and are in depressions. Miami soils are on higher positions than Crosby soils and have a brown B horizon that is free of mottles.

Typical pedon of Crosby silt loam, 0 to 3 percent slopes, in a cultivated field 725 feet south and 1,200 feet west of the northeast corner of sec. 36, T. 19 N., R. 3 E.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; moderate medium and coarse granular structure; friable; slightly acid; abrupt smooth boundary.

A2—8 to 11 inches; grayish brown (10YR 5/2) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium granular structure; friable; slightly acid; abrupt smooth boundary.

B21t—11 to 16 inches; dark yellowish brown (10YR 4/4) silty clay loam; many medium distinct grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; firm; few very fine pores; common continuous distinct thin very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) clay films on faces of peds; common black (10YR 2/1) concretions of iron and manganese oxide; medium acid; clear smooth boundary.

IIB22t—16 to 22 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct gray (10YR 5/1) and grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to strong medium angular and subangular blocky; firm; few very fine pores; common continuous distinct medium dark grayish brown (2.5Y 4/2) clay films on faces of peds; many black (10YR 2/1) concretions of iron and manganese oxide; slightly acid; clear smooth boundary.

IIB23t—22 to 27 inches; yellowish brown (10YR 5/4) clay loam; many coarse distinct gray (10YR 5/1) and dark gray (10YR 4/1) mottles; moderate medium and coarse subangular blocky structure; firm; common fine pores; common continuous distinct medium dark grayish brown (2.5Y 4/2) clay films on faces of peds and in root channels; 3 percent gravel; neutral; clear smooth boundary.

IIB3—27 to 32 inches; dark yellowish brown (10YR 4/4) clay loam; many medium distinct gray (10YR 5/1) and grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; firm; many fine pores; common discontinuous distinct thin dark grayish brown (10YR 4/2) clay films on faces of peds and in root channels; 5 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC—32 to 60 inches; brown (10YR 4/3) loam; many medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; firm; few fine pores; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. Some areas have a B1 horizon. The B1 horizon, where present, is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) silt loam or silty clay loam. The B2 horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 6. The upper part of the B2 horizon is silty clay loam or clay loam. The lower part of the B2 horizon and the B3 horizon is loam, sandy clay loam, or clay loam. Reaction is strongly acid to neutral in the B1 and B2 horizons and is slightly acid to mildly alkaline in the B3 horizon. The B3 horizon has slight effervescence in some profiles. The C horizon is brown (10YR 5/3) or yellowish brown (10YR 5/4) loam, sandy loam, or clay loam.

Fox series

The Fox series consists of well drained soils on terraces and small knolls on uplands. Permeability is moderate in the subsoil and rapid in the underlying material. These soils formed in 24 to 40 inches of loamy outwash underlain by loose sand and gravelly coarse sand. Slopes range from 0 to 18 percent.

Fox soils are similar to Nineveh and Ockley soils and are adjacent to these soils on many landscapes. Fox soils are also adjacent to Miami and Sleeth soils on many landscapes. Nineveh soils have a mollic surface layer. Ockley soils are deeper to sand and gravelly sand than Fox soils. Miami soils have less gravel in the solum than Fox soils and have underlying material that consists of loam till. Sleeth soils have a mottled B horizon.

Typical pedon of Fox loam, 2 to 6 percent slopes, eroded, in a cultivated field 1,620 feet south and 1,040 feet east of the northwest corner of sec. 5, T. 19 N., R. 6 E.:

Ap—0 to 6 inches; dark brown (10YR 4/3) loam; moderate fine granular structure; friable; 3 percent gravel; neutral; clear smooth boundary.

B1—6 to 10 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; firm; common fine roots; few fine pores; 5 percent gravel; neutral; abrupt smooth boundary.

B21t—10 to 16 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few fine roots; common fine pores; common thin continuous dark brown (7.5YR 4/2) clay films on faces of peds; 10 percent gravel; slightly acid; clear smooth boundary.

B22t—16 to 24 inches; dark brown (7.5YR 4/4) gravelly clay loam; moderate medium subangular blocky structure; firm; few fine roots; few medium pores; many thin patchy dark brown (7.5YR 4/2) and few thin continuous dark reddish gray (5YR 4/2) clay films on faces of peds; 18 percent gravel; slightly acid; clear wavy boundary.

B23t—24 to 30 inches; reddish brown (5YR 4/4) gravelly sandy clay loam; weak fine subangular blocky structure; firm; very few roots; few medium pores; common patchy dark reddish gray (5YR 4/2) clay films on faces of peds; 20 percent gravel; slightly acid; gradual wavy boundary.

B3t—30 to 36 inches; dark reddish brown (5YR 3/4) sandy clay loam; weak fine subangular blocky structure; friable; few thin patchy dark reddish brown (5YR 3/2) clay films on faces of peds; 5 percent gravel; neutral; abrupt irregular boundary.

IIC—36 to 60 inches; brown (10YR 5/3) sand and gravelly coarse sand; single grain; loose; gravel content increases with depth; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 40 inches. The A horizon has hue of 10YR, value of 4, and chroma of 2 to 4. It is silt loam, loam, sandy loam, gravelly loam, or gravelly sandy loam. The B2 horizon has hue of 7.5YR or 10YR, value of 4, and chroma of 3 or 4. It is clay loam, gravelly sandy clay loam, or gravelly clay loam, and thin subhorizons are silty clay loam and silt loam. Reaction is slightly acid or medium acid in the upper part of the B horizon and is slightly acid to mildly alkaline in the lower part. The B horizon contains 0 to 25 percent gravel.

Genesee series

The Genesee series consists of deep, well drained, moderately permeable soils on flood plains. These soils

formed in mildly alkaline or moderately alkaline, loamy alluvium. Slopes range from 0 to 2 percent.

In this survey area, these soils have free carbonates closer to the surface than is defined as the range for the Genesee series. However, this difference does not affect the use or behavior of the soils.

Genesee soils are adjacent to Fox, Ross, and Shoals soils. Fox soils have an argillic horizon, and they have more gravel and are in a slightly higher position on the landscape than Genesee soils. Ross soils have a mollic surface layer that is more than 24 inches thick. Shoals soils have a mottled C horizon and are commonly in a lower position than Genesee soils.

Typical pedon of Genesee silt loam, in a cultivated field 1,510 feet east and 2,610 feet north of the southwest corner of sec. 13, T. 18 N., R. 4 E.:

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam; moderate coarse granular structure; friable; few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 18 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; friable; few fine roots; many very fine pores; many dark grayish brown (2.5Y 4/2) worm casts; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—18 to 38 inches; brown (10YR 4/3) loam; weak fine and medium subangular blocky structure; friable; few fine roots; many very fine pores; common shell fragments 2 to 10 millimeters in size; strong effervescence; moderately alkaline.

C3—38 to 60 inches; stratified brown (10YR 4/3) silt loam and loam; massive; friable; strong effervescence; moderately alkaline.

The A horizon is dark grayish brown (10YR 4/2), brown (10YR 5/3), dark yellowish brown (10YR 4/4), or dark brown (10YR 3/3). It is commonly silt loam or loam, but in some places it is sandy loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline. The C horizon is dark yellowish brown (10YR 4/4) or brown (10YR 4/3 and 5/3) stratified silt loam, loam, or sandy loam. In some profiles loamy sand and sand lenses that are 1 to 4 inches thick are below a depth of 40 inches.

Hennepin series

The Hennepin series consists of deep, well drained, moderately slowly permeable soils on steep breaks along till plains. These soils formed in glacial till. Slopes range from 18 to 50 percent.

In many areas Hennepin soils are near Fox and Miami soils. Fox soils have an argillic horizon, have more gravel in the solum than Hennepin soils, and have underlying material of loose sand and gravel. Miami soils are on ridgetops. They have an argillic horizon, and they are less sloping and have a thicker solum than Hennepin soils.

Typical pedon of Hennepin loam, 18 to 50 percent slopes, in a wooded area 525 feet north and 1,120 feet east of the southwest corner of sec. 36, T. 19 N., R. 4 E.:

A1—0 to 4 inches; dark grayish brown (10YR 4/2) loam; moderate medium granular structure; friable; many fine roots; 10 percent gravel; neutral; clear smooth boundary.

B2—4 to 11 inches; yellowish brown (10YR 5/4) loam; moderate fine and medium subangular blocky structure; friable; many fine roots; 15 percent gravel; slight effervescence; moderately alkaline; abrupt wavy boundary.

C—11 to 60 inches; brown (10YR 5/3) loam; massive; friable; few fine roots; 10 percent gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 10 to 20 inches. The A horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2) loam or light clay loam. The B horizon is loam or light clay loam. Reaction is neutral or mildly alkaline. The C horizon is clay loam or loam.

Houghton series

The Houghton series consists of deep, very poorly drained, moderately rapidly permeable soils in depressions on uplands and outwash terraces. These soils formed in organic material more than 51 inches thick. Slopes range from 0 to 2 percent.

Houghton soils are similar to Palms soils and are adjacent to Brookston, Patton, and Westland soils. Palms soils have mineral material at a depth of 20 to 51 inches. Brookston, Patton, and Westland soils have a mineral solum.

Typical pedon of Houghton muck, in a wooded area 355 feet west and 1,221 feet south of the northeast corner of sec. 24, T. [illegible] N., R. 4 E.:

Oa1—0 to 5 inches; black (N 2/0) sapric material, broken face and rubbed; less than 1 percent fiber undisturbed and rubbed; moderate fine and very fine granular structure; friable; many fine roots; 15 to 25 percent mineral soil material; neutral; abrupt smooth boundary.

Oa2—5 to 9 inches; black (N 2/0) sapric material, broken face and rubbed; less than 1 percent fiber undisturbed and rubbed; weak medium subangular blocky structure parting to weak medium granular; friable; many fine roots; 15 percent mineral soil material; neutral; abrupt smooth boundary.

Oa3—9 to 27 inches; dark reddish brown (5YR 3/2) sapric material, broken face; very dark gray (N 3/0) rubbed, black (10YR 2/1) crushed; about 30 percent fiber, less than 5 percent fiber rubbed; weak thick platy structure; friable; many fine roots; 15 to 20 percent mineral soil material; neutral; gradual wavy boundary.

Oa4—27 to 37 inches; black (N 2/0) sapric material, broken face; brown (5YR 3/3) rubbed, dark reddish brown (5YR 3/2) crushed; about 10 percent fiber, about 1 percent fiber crushed; massive; friable; few fine roots; neutral; gradual wavy boundary.

Oa5—37 to 60 inches; very dark gray (10YR 3/1) sapric material, broken face; black (10YR 2/1) rubbed; about 50 percent fiber, about 10 percent fiber rubbed; massive; friable; neutral; gradual wavy boundary.

The organic deposits are more than 51 inches thick. Reaction is slightly acid or neutral. The surface tier is black (10YR 2/1 and N 2/0) and is dominantly sapric material. It is 5 to 25 percent mineral soil material. The bottom tier is dominantly sapric material but contains hemic and fibric layers 5 to 8 inches thick in some pedons. Color below the surface layer is very dark grayish brown (10YR 2/2 or 2.5Y 3/2), black (N 2/0), or dark reddish brown (5YR 2/2 and 3/2).

Miami series

The Miami series consists of deep, well drained soils on till plains. Permeability is moderate in the subsoil and moderately slow in the underlying material. These soils formed in 8 to 20 inches of loess and in the underlying glacial till. Slopes range from 0 to 18 percent.

Miami soils are similar to Fox soils and are adjacent to Brookston and Crosby soils on many landscapes. Brookston soils have a mollic surface layer. Crosby soils have a yellowish brown, mottled B horizon. Fox soils have more gravel in the solum than Miami soils and have loose sand and gravelly sand in the underlying material.

Typical pedon of Miami silt loam, 2 to 6 percent slopes, eroded, in an idle field 792 feet east and 2,376 feet south of the northwest corner of sec. 36, T. 18 N., R. 3 E.:

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam; moderate medium granular structure; friable; many roots; neutral; abrupt smooth boundary.

B21t—7 to 10 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine and very fine subangular blocky structure; firm; many roots; 2 percent gravel; slightly acid; clear smooth boundary.

B22t—10 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; common roots; common very fine continuous pores; few discontinuous thin dark brown (10YR 4/3) clay films on faces of peds; 3 percent gravel; few bleached sand grains; medium acid; clear smooth boundary.

B23t—16 to 25 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; few roots; common very fine continuous pores; common continuous thin dark brown (7.5YR 4/3) clay films on faces of peds; few bleached sand grains; 3 percent gravel; medium acid; clear smooth boundary.

B24t—25 to 30 inches; brown (10YR 4/3) clay loam; moderate medium and coarse subangular blocky structure; firm; few roots; common very fine and fine pores; many continuous thin dark brown (7.5YR 4/3) clay films on faces of peds; 3 percent gravel; neutral; abrupt smooth boundary.

C—30 to 60 inches; yellowish brown (10YR 5/4) loam; massive; firm; few continuous medium dark brown (10YR 3/3) clay films in cracks and root channels; 5 percent gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 42 inches. The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is silt loam or loam. Reaction is medium acid to neutral. Some wooded areas have a dark grayish brown (10YR 3/2) surface layer. The B1 horizon, where present, has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is silty clay loam or silt loam. The B2 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam, loam, or sandy clay loam. The most acid part of the B2 horizon is medium acid or strongly acid. Reaction in some subhorizons is slightly acid or neutral. The B3 horizon, where present, is sandy loam, loam, clay loam, or sandy clay loam and is slightly acid to mildly alkaline. The C horizon is brown (10YR 5/3) or yellowish brown (10YR 5/4) loam, sandy loam, or light clay loam.

Milton Variant

The Milton Variant consists of deep, well drained, moderately permeable soils on terraces. These soils formed in loamy outwash underlain by limestone. Slopes range from 0 to 2 percent.

Milton soils are similar to Ockley soils and are commonly adjacent to Patton soils and Randolph Variant soils. Ockley soils have a substratum of sand and gravelly sand. Patton soils have a mollic surface layer. Randolph Variant soils have gray mottles in the B horizon.

Typical pedon of Milton Variant silt loam, 0 to 2 percent slopes, in a cultivated area 2,620 feet south and 1,480 feet east of the northwest corner of sec. 29, T. 19 N., R. 6 E.:

Ap—0 to 8 inches; brown (10YR 4/3) silt loam; weak fine granular structure; friable; common roots; neutral; abrupt smooth boundary.

B1—8 to 11 inches; strong brown (7.5YR 5/6) silt loam; moderate fine subangular blocky structure; firm; common fine roots; few patchy thin dark yellowish brown (10YR 4/4) clay films on faces of peds; neutral; clear wavy boundary.

B21t—11 to 19 inches; dark brown (7.5YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; few patchy thin dark reddish brown (5YR 3/3) and common continuous thin yellowish red (5YR 5/6) clay films on faces of peds; 7 percent gravel; neutral; clear wavy boundary.

B22t—19 to 26 inches; reddish brown (5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common continuous thin dark brown (7.5YR 4/2) clay films on faces of peds; light yellowish brown (2.5YR 6/2) silt surrounding soft limestone fragments; 14 percent coarse fragments, many of which are limestone; common fine black (10YR 2/1) soft accumulations of iron and manganese oxide; medium acid; gradual irregular boundary.

B23t—26 to 37 inches; dark reddish brown (5YR 3/4) flaggy clay; weak medium subangular blocky structure; firm; common continuous thin dark brown (7.5YR 4/2) clay films on faces of peds; light yellowish brown (2.5Y 6/4) silt surrounding soft limestone fragments; common discontinuous distinct thin black (10YR 2/1) concretions and soft accumulations of iron and manganese oxide; 40 percent coarse fragments as much as 15 inches in diameter but dominantly 5 to 10 inches in diameter; medium acid; gradual irregular boundary.

B24t—37 to 41 inches; dark reddish brown (5YR 3/4) flaggy clay loam; moderate fine and very fine subangular blocky structure; firm; common discontinuous thin dark reddish gray (5YR 4/2) clay films on faces of peds; light yellowish brown (2.5Y 6/4) silt surrounding soft limestone fragments; many black (10YR 2/1) concretions and accumulations of iron and manganese oxide; 25 percent coarse fragments as much as 10 inches in diameter; slightly acid; abrupt wavy boundary.

IICr—41 to 46 inches; light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) soft limestone; slight effervescence; moderately alkaline; abrupt irregular boundary.

IIR—46 inches; hard limestone.

Thickness of the solum ranges from 35 to 50 inches. Depth to hard limestone ranges from 40 to 50 inches. The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. The B horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 3 to 6. It is silty clay loam, clay loam, or clay. Reaction is neutral to medium acid in the upper part of the B horizon and is slightly acid, neutral, or, less commonly, mildly alkaline in the lower part. In some places the lower part of the B horizon contains as much as 35 percent coarse fragments, mostly weathered limestone. Thickness of the IICr horizon ranges from 3 to 15 inches.

Nineveh series

The Nineveh series consists of well drained soils that are moderately deep over sand and gravelly coarse sand. These soils are on terraces along White River. Permeability is moderate in the subsoil and very rapid in the underlying material. These soils formed in 24 to 40 inches of neutral loamy outwash underlain by sand and gravelly coarse sand. Slopes range from 0 to 2 percent.

Nineveh soils are similar to Fox and Ockley soils and are adjacent to Sleeth and Westland soils on many landscapes. Fox, Ockley, and Sleeth soils have an ochric surface layer. Sleeth soils also have a mottled B horizon. Westland soils have more clay in the A horizon than Nineveh soils and have a dark gray B horizon.

Typical pedon of Nineveh loam, 0 to 2 percent slopes, in a cultivated area 925 feet north and 920 feet east of the southwest corner of sec. 16, T. 19 N., R. 5 E.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many fine roots; many medium pores; slightly acid; abrupt smooth boundary.

A3—8 to 12 inches; dark brown (7.5YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; friable; many fine roots; common medium pores; 5 percent gravel; slightly acid; clear smooth boundary.

B21t—12 to 20 inches; brown (7.5YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; common fine roots; common medium pores; common continuous thin dark brown (7.5YR 3/2) clay films on most faces of peds; 7 percent gravel; neutral; clear smooth boundary.

B22t—20 to 30 inches; brown (7.5YR 4/4) gravelly clay loam; moderate fine and medium subangular blocky structure; firm; few fine roots; common medium pores; few continuous thin dark brown (7.5YR 3/2) clay films on faces of peds; 20 percent gravel; neutral; abrupt wavy boundary.

B3t—30 to 32 inches; brown (7.5YR 4/4) gravelly clay loam; moderate fine and medium subangular blocky structure; firm; common medium pores; many continuous thick dark reddish brown (5YR 3/2) clay films on faces of peds, bridging sand grains, on coarse fragments, and in voids; 15 percent gravel; neutral; abrupt irregular boundary.

IIC—32 to 60 inches; pale brown (10YR 6/3) stratified sand and gravelly sand; tongues of soil material from the B3t horizon extend to a depth of 50 inches and range in width from 2 to 5 inches; single grain; loose; 40 percent gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 40 inches. The A horizon has hue of 7.5YR or 10YR, value of 3, and chroma of 2 or 3. It is loam or silt loam. The B horizon has hue of 7.5YR, value of 3 or 4, and chroma of 2 or 4. It is clay loam or gravelly clay loam. Reaction in the B horizon is slightly acid or neutral. The B3 horizon has hue of 7.5YR, value of 3 or 4, and chroma of 2. It is clay loam, sandy clay loam, gravelly clay loam, or gravelly sandy clay loam. Reaction in the B3 horizon is neutral or mildly alkaline.

Ockley series

The Ockley series consists of deep, well drained, moderately permeable soils on terraces. These soils formed in more than 40 inches of loamy outwash underlain by sand and gravelly coarse sand. Slopes range from 0 to 6 percent.

Ockley soils are similar to Fox soils and are near Nineveh and Sleeth soils on many landscapes. Fox soils have sand and gravelly sand at a depth of less than 40 inches. Nineveh soils have a mollic surface layer. Sleeth soils have a mottled B horizon and are commonly in slightly lower positions.

Typical pedon of Ockley silt loam, 0 to 2 percent slopes, in a pasture 1,920 feet north and 880 feet west of the southeast corner of sec. 13, T. 19 N., R. 5 E.:

Ap—0 to 10 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine granular structure; friable; many roots; neutral; abrupt smooth boundary.

B1—10 to 17 inches; brown (10YR 4/3) loam; moderate fine subangular blocky structure; friable; many roots; neutral; clear wavy boundary.

B21t—17 to 28 inches; brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few roots; few thin patchy brown (7.5YR 4/4) clay films on faces of peds; slightly acid; clear wavy boundary.

B22t—28 to 37 inches; brown (7.5YR 4/4) clay loam; moderate coarse subangular blocky structure; firm; common discontinuous thin dark reddish brown (5YR 3/3) clay films on faces of peds; 15 percent gravel; medium acid; clear wavy boundary.

B23t—37 to 45 inches; dark yellowish brown (10YR 4/4) clay loam; weak coarse subangular blocky structure; firm; few thin patchy faint brown (7.5YR 4/4) clay films on faces of peds; 5 percent gravel; medium acid; clear wavy boundary.

B31t—45 to 50 inches; dark yellowish brown (10YR 4/4) loam; weak coarse subangular blocky structure; firm; few thin patchy distinct dark brown (7.5YR 4/4) clay films on faces of peds; 10 percent gravel; medium acid; clear wavy boundary.

B32t—50 to 56 inches; dark reddish brown (5YR 3/3) gravelly sandy clay loam; weak medium subangular blocky structure; firm; 25 percent gravel; medium acid; abrupt wavy boundary.

IIC—56 to 72 inches; yellowish brown (10YR 5/4) stratified sand and gravelly coarse sand; single grain; loose; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 40 to 60 inches. The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 4. It is loam or silt loam. The B1 horizon is silty clay loam or clay loam. The B2 horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 3 or 4. It is mainly clay loam or gravelly clay loam, but some subhorizons are loam or sandy clay loam. The B3 horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 to 4, and chroma of 2 to 4. It is sandy loam, sandy clay loam, clay loam, gravelly clay loam, or gravelly sandy clay loam. The lower part of the B horizon contains 10 to 30 percent gravel. In many profiles, tongues of material from the B horizon extend to a depth of 80 inches.

Palms series

The Palms series consists of deep, very poorly drained soils in depressions on terraces and uplands. Permeability is moderately rapid in the organic layer and is moderate to moderately slow in the mineral soil material. The soils formed in 16 to 50 inches of organic material underlain by loamy mineral soil material. Slopes range from 0 to 2 percent.

Palms soils are similar to Houghton soils and are near Brookston, Patton, and Westland soils on many landscapes. Houghton soils formed in more than 51 inches of organic material. Brookston, Patton, and Westland soils formed in mineral soil material.

Typical pedon of Palms muck, in a cultivated field 1,100 feet west and 2,550 feet south of the northeast corner of sec. 10, T. 18 N., R. 4 E.:

Oap—0 to 9 inches; black (N 2/0) sapric material, broken face and rubbed; less than 1 percent fiber rubbed; moderate fine and very fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

Oa2—9 to 17 inches; black (N 2/0) sapric material, broken face and rubbed; less than 1 percent fiber rubbed; moderate medium granular structure; friable; common fine roots; neutral; clear wavy boundary.

Oa3—17 to 29 inches; black (10YR 2/1) sapric material, broken face and rubbed; less than 1 percent fiber rubbed; weak medium platy structure parting to weak medium subangular blocky; friable; few dark reddish brown (5YR 3/3) accumulations of iron on faces of peds; neutral; clear wavy boundary.

IIC1—29 to 41 inches; very dark gray (N 3/0) silty clay loam; massive; firm; neutral; clear wavy boundary.

IIC2—41 to 60 inches; gray (N 5/0) stratified silty clay loam and clay loam; massive; firm; 5 percent gravel; slight effervescence; moderately alkaline.

Thickness of the organic material ranges from 16 to 40 inches. In the surface tier the organic material is black (N 2/0 or 10YR 2/1) or dark brown (7.5YR 3/2). In the subsurface it has these colors and is also dark reddish brown (5YR 3/3), dark brown (7.5YR 3/2), or very dark brown (10YR 2/2). The material is dominantly sapric, but thin layers of hemic material are present. Reaction in the organic material is medium acid to neutral. The organic horizons contain 5 to 25 percent mineral soil material. The C horizon is black (N 3/0), gray (N 5/0 or 10YR 5/1), or dark gray (10YR 4/1). It is loam, silty clay loam, clay loam, or silt loam and

has thin subhorizons of sandy material in some pedons. Reaction is neutral to moderately alkaline.

Patton series

The Patton series consists of deep, poorly drained, moderately permeable soils in depressions and sluiceways. These soils formed in lacustrine silt and clay. Slopes range from 0 to 2 percent.

Patton soils are near Brookston, Crosby, and Whitaker soils on many landscapes. Brookston soils have more sand in the solum than Patton soils and have underlying material of loam till. Crosby and Whitaker soils are in a slightly higher position than Patton soils, and they have a light colored surface layer.

Typical pedon of Patton silty clay loam, in a cultivated field 1,800 feet south and 1,056 feet west of the northeast corner of sec. 30, T. 20 N., R. 5 E.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam; moderate medium and coarse granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) silty clay loam; weak fine and medium angular and subangular blocky structure; firm; many fine roots; common fine pores; neutral; abrupt smooth boundary.

B21tg—12 to 19 inches; dark gray (10YR 4/1) silty clay loam; many fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate very fine and fine subangular blocky; firm; common roots; common fine pores; common fine continuous thin black (10YR 2/1) organic coatings and clay films on faces of peds; neutral; clear smooth boundary.

B22tg—19 to 28 inches; olive gray (5Y 5/2) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; firm; common roots; many fine pores; common continuous thin dark gray (10YR 4/1) clay films on faces of peds; common continuous thin black (10YR 2/1) organic coatings in root and worm channels; neutral; clear smooth boundary.

B23tg—28 to 38 inches; light olive gray (5Y 6/2) silty clay loam; many coarse prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few roots; many fine pores; few continuous distinct thin gray (10YR 5/1) silt and clay films on faces of peds; neutral; abrupt smooth boundary.

C1—38 to 49 inches; olive gray (5Y 5/2) silt loam; many coarse prominent yellowish brown (10YR 5/6) and dark brown (7.5YR 4/4) mottles; weak medium and coarse subangular blocky structure; friable; few roots; common fine pores; slight effervescence; moderately alkaline; abrupt smooth boundary.

C2—49 to 60 inches; gray (5Y 5/1) and olive gray (5Y 5/2) silt loam and light silty clay loam; many coarse distinct light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/4) mottles; massive; friable; few small white (5Y 8/1) shells; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 42 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam or silty clay loam. Thickness of the A horizon ranges from 12 to 18 inches. The B horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is commonly silty clay loam, but thin subhorizons of silt loam or silty clay are in some pedons. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 or 6, and chroma of 1 or 2. It is silt loam or silty clay loam, and thin layers of loamy material are in many pedons. Reaction in the C horizon is neutral to moderately alkaline.

Randolph Variant

The Randolph Variant consists of deep, somewhat poorly drained, moderately slowly permeable soils on terraces. These soils formed in loamy outwash underlain by limestone. Slopes range from 0 to 2 percent.

Randolph Variant soils are similar to Crosby, Sleeth, and Whitaker soils and are commonly adjacent to Milton and Patton soils. Crosby, Sleeth, and Whitaker soils do not have limestone in the substratum. Milton soils have a brown B horizon that is free of mottles. Patton soils have a mollic surface layer.

Typical pedon of Randolph Variant silt loam, in a cultivated field 200 feet west and 2,420 feet south of the northeast corner of sec. 30, T. 19 N., R. 6 E.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; moderate medium granular structure; friable; common fine roots; slightly acid; abrupt smooth boundary.

A2—8 to 12 inches; dark grayish brown (10YR 4/2) silt loam; moderate fine subangular blocky structure; friable; common fine roots; slightly acid; clear smooth boundary.

B21t—12 to 17 inches; yellowish brown (10YR 5/6) clay loam; many medium distinct gray (10YR 5/1) mottles; moderate medium subangular blocky structure; friable; few fine roots; many thin continuous grayish brown (10YR 5/2) clay films in voids and on faces of peds; 2 percent gravel; medium acid; clear smooth boundary.

B22t—17 to 27 inches; dark yellowish brown (10YR 4/6) clay loam; many medium distinct gray (10YR 5/1) mottles; moderate medium subangular blocky structure; firm; few roots; common continuous thin grayish brown (10YR 5/2) clay films on faces of peds; 3 percent gravel; medium acid; clear smooth boundary.

B23t—27 to 35 inches; dark yellowish brown (10YR 4/4) clay loam; many medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; thin continuous dark brown (7.5YR 3/2) clay films on faces of peds; few soft black (10YR 2/1) accumulations of iron and manganese oxide; 15 percent gravel and limestone fragments; neutral; gradual wavy boundary.

B24t—35 to 38 inches; dark yellowish brown (10YR 5/4) clay loam; common fine distinct gray (10YR 5/1) mottles; weak coarse subangular blocky structure; firm; few thin patchy dark brown (7.5YR 4/2) clay films on faces of peds; 10 percent gravel and limestone fragments; slightly acid; clear smooth boundary.

IIB3—38 to 41 inches; light olive brown (2.5Y 5/6) silty clay loam; many medium distinct gray (10YR 6/1) mottles; weak coarse subangular blocky structure; firm; few thin patchy dark brown (7.5YR 4/2) clay films on faces of peds; 10 percent weathered limestone fragments; neutral; clear smooth boundary.

IICr—41 to 44 inches; light gray (10YR 7/1) soft limestone; slight effervescence; moderately alkaline.

IIR—44 inches; hard limestone.

Thickness of the solum ranges from 35 to 50 inches. Depth to hard limestone ranges from 40 to 50 inches. The A horizon is dark gray (10YR 4/1) or dark grayish brown (10YR 4/2). The B horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 6. It has common to many mottles. The B2 horizon is silty clay loam or clay loam and formed in outwash that had a high content of limestone fragments. The content of coarse fragments in the B2 horizon ranges from 0 to 25 percent. Reaction is strongly acid to slightly acid in the upper part of the B2 horizon and is slightly acid or neutral in the lower part. The B3 horizon formed in material weathered from limestone and is silty clay or silty clay loam. The content of coarse fragments in this horizon is as much as 30 percent. Reaction in the B3 horizon is neutral or mildly alkaline. In some areas there is no B3 horizon. Thickness of the IICr horizon ranges from 3 to 15 inches.

Ross series

The Ross series consists of deep, well drained, moderately permeable soils on broad flood plains. These soils formed in neutral or moderately alkaline, loamy alluvium. Slopes range from 0 to 2 percent.

Ross soils are adjacent to Genesee, Nineveh, and Shoals soils. Genesee and Shoals soils have an ochric surface layer. Nineveh soils have a thinner mollic surface layer, have more gravel in the solum, and are in a slightly higher position than Ross soils.

Typical pedon of Ross loam, in a cultivated field 1,122 feet west and 200 feet south of the northeast corner of sec. 26, T. 18 N., R. 4 E.:

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam; strong coarse granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) loam; moderate coarse granular structure; friable; common fine roots; neutral; clear smooth boundary.

A13—14 to 28 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) crushed; moderate medium and coarse granular structure; friable; many fine roots; common fine pores; neutral; clear smooth boundary.

A14—28 to 34 inches; dark brown (10YR 3/3) loam; moderate fine granular structure; friable; common fine roots; few very fine pores; common thin very dark grayish brown (10YR 3/2) organic coatings on all faces of peds; neutral; clear smooth boundary.

C1—34 to 53 inches; brown (10YR 4/3) loam; massive; friable; few fine roots; few fine pores; common medium very dark grayish brown (10YR 3/2) organic coatings on faces of peds and in root and worm channels; neutral; clear smooth boundary.

C2—53 to 60 inches; dark yellowish brown (10YR 4/4) sandy clay loam; massive; very friable; neutral; abrupt smooth boundary.

Thickness of the A horizon ranges from 24 to 40 inches. The A horizon is loam or silt loam. Reaction is neutral to mildly alkaline, and in a few areas the A horizon contains carbonates. The C horizon is clay loam, loam, sandy loam, or sandy clay loam or is gravelly analogs of these textures. Reaction is neutral to moderately alkaline, and in many areas the C horizon contains carbonates.

Shoals series

The Shoals series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in neutral or mildly alkaline, loamy alluvium. Slopes range from 0 to 2 percent.

Shoals soils are adjacent to Genesee and Sloan soils on many landscapes. Genesee soils have a brown C1 horizon that is free of mottles. Sloan soils have a mollic surface layer and are in depressions.

Typical pedon of Shoals silt loam, in a pasture 1,765 feet north and 2,365 feet west of the southeast corner of sec. 31, T. 18 N., R. 3 E.:

A11—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; moderate coarse granular structure; friable; many roots; neutral; clear smooth boundary.

A12—6 to 11 inches; dark grayish brown (10YR 4/2) silt loam; common fine distinct brown (7.5YR 4/4) mottles; moderate coarse granular structure; friable; common roots; few discontinuous thin light brownish gray (10YR 6/2) silt coatings on faces of peds; neutral; clear smooth boundary.

C1—11 to 15 inches; dark grayish brown (10YR 4/2) silt loam; many fine distinct brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few roots; many very fine pores; few dark gray (10YR 4/1) organic fillings in old root channels; neutral; clear smooth boundary.

C2—15 to 39 inches; grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) loam; many medium distinct brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky and moderate and coarse granular structure; friable; few fine roots; few very fine pores; few very dark gray (10YR 3/1) organic fillings in worm channels; neutral; clear smooth boundary.

C3—39 to 52 inches; gray (10YR 5/1) sandy loam; many coarse distinct brown (7.5YR 4/4) mottles; massive; friable; few very fine roots; common dark gray (10YR 4/1) organic fillings in cracks and old root channels; neutral; abrupt smooth boundary.

C4—52 to 56 inches; very dark gray (10YR 3/1) sandy clay loam; many coarse distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; massive; friable; very few roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

C5—56 to 60 inches; grayish brown (10YR 5/2) fine gravel and coarse sand; single grain; loose; slight effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2. It is silt loam, loam, or silty clay loam. The C horizon has hue of 10YR, value of 3 to 6, and chroma of 1 to 4. The upper part of the C horizon is commonly silt loam or loam, but in places it is sandy loam, clay loam, and silty clay loam. In many areas loose sand and gravel are below a depth of 42 inches. In the C horizon above a depth of 40 inches, reaction is neutral or mildly alkaline. In a few profiles carbonates are below a depth of 20 inches.

Sleeth series

The Sleeth series consists of deep, somewhat poorly drained, moderately permeable soils on terraces. These soils formed in more than 40 inches of loamy outwash underlain by sand and gravelly sand. Slopes range from 0 to 2 percent.

Sleeth soils are similar to Whitaker soils and are adjacent to Ockley and Westland soils. Whitaker soils have less gravel in the solum than Sleeth soils and have a C horizon of sand and silt loam. Ockley soils have a brown B horizon that is free of mottles. Westland soils have a mollic surface layer that is finer textured than the surface layer of Sleeth soils.

Typical pedon of Sleeth loam, in a wooded area 990 feet east and 858 feet north of the southwest corner of sec. 23, T. 18 N., R. 4 E.:

A1—0 to 9 inches; dark grayish brown (10YR 4/2) loam; moderate medium granular structure; friable; many roots; common very fine pores; 2 percent gravel; medium acid; abrupt smooth boundary.

A12—9 to 11 inches; dark grayish brown (10YR 4/2) loam; moderate coarse granular structure; friable; many roots; common very fine pores; 2 percent gravel; medium acid; abrupt smooth boundary.

B1—11 to 15 inches; grayish brown (10YR 5/2) loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; common roots; common very fine pores; few dark grayish brown (10YR 4/2) fillings in root and worm channels; many continuous distinct thin grayish brown (2.5Y 5/2) silt and clay coatings on faces of peds; medium acid; clear smooth boundary.

B21t—15 to 20 inches; light brownish gray (2.5Y 6/2) clay loam; many medium distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; many roots; many very fine pores; many continuous distinct thin grayish brown (10YR 5/2) silt and clay coatings on faces of peds; few thin black (10YR 2/1) coatings of manganese oxide on faces of peds; slightly acid; clear smooth boundary.

B22t—20 to 34 inches; yellowish brown (10YR 5/6) sandy clay loam; many coarse distinct grayish brown (2.5Y 5/2) mottles; moderate medium and coarse subangular blocky structure; firm; common roots; many fine pores; many continuous thin dark gray (5Y 4/1) clay films on faces of peds; 5 percent gravel; neutral; abrupt smooth boundary.

B31t—34 to 39 inches; dark gray (10YR 4/1) sandy clay loam; weak coarse subangular blocky structure; friable; few roots; few very fine pores; many continuous medium very dark gray (5Y 3/1) and dark gray (5Y 4/1) clay and organic films on faces of peds; 10 percent gravel; neutral, except few white (10YR 8/1) coatings of calcium carbonate on gravel fragments are moderately alkaline; abrupt wavy boundary.

B32t—39 to 47 inches; dark gray (10YR 4/1) sandy clay loam; very weak coarse subangular blocky structure; friable; few roots; few medium pores; common continuous thin dark gray (N 4/0) clay films on faces of peds and on gravel fragments; 10 percent gravel; neutral; abrupt wavy boundary.

IIC—47 to 60 inches; dark gray (10YR 4/1) and light brownish gray (2.5Y 6/2) coarse sand and fine gravelly sand; single grain; loose; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 40 to 60 inches. The A horizon is dark grayish brown (10YR 4/2), dark gray (10YR 4/1), or brown (10YR 4/3) loam or silt loam. The B1 horizon is loam or silt loam. The B2 horizon has hue of 10YR, value of 5 or 6, and chroma of 1 to 6. It is silty clay loam, clay loam, sandy clay loam, gravelly clay loam, or gravelly sandy clay loam. The B2 horizon contains 5 to 30 percent gravel. Reaction in the B horizon is medium acid to neutral and generally is less acid with increasing depth. In the C horizon, the sand size ranges from medium to very coarse and the gravel content ranges from 15 to 40 percent.

Sloan series

The Sloan series consists of deep, very poorly drained, moderately permeable soils on flood plains. These soils formed in neutral or mildly alkaline, loamy alluvium. Slopes range from 0 to 2 percent.

Sloan soils are similar to Westland soils and are adjacent to Genesee and Shoals soils. Westland soils have more gravel in the solum than Sloan soils and have a C horizon of sand and gravel. Genesee and Shoals soils have an ochric surface layer and are browner than Sloan soils.

Typical pedon of Sloan silty clay loam, sandy substratum, in a cultivated field 1,300 feet south and 1,000 feet east of the northwest corner of sec. 7, T. 18 N., R. 5 E.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine and medium subangular blocky structure; friable; common roots; many very fine and fine pores; 1 percent gravel; neutral; abrupt smooth boundary.

A12—8 to 13 inches; very dark grayish brown (10YR 3/2) clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; friable; common roots; common very fine and fine pores; 3 percent gravel; neutral; clear smooth boundary.

B21g—13 to 27 inches; dark gray (10YR 4/1) clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few roots; common very fine pores; few discontinuous distinct thin very dark gray (10YR 3/1) clay films on most faces of peds; 3 percent gravel; neutral; abrupt smooth boundary.

B22g—27 to 34 inches; dark gray (10YR 4/1) clay loam; many medium distinct dark yellowish brown (10YR 4/4) and dark brown (7.5YR 4/4) mottles; weak medium and coarse subangular blocky structure; friable; few roots; common fine pores; few discontinuous distinct thin very dark gray (5Y 3/1) clay films coating gravel fragments and filling cracks; 5 percent gravel; few fine white (5Y 8/1) secondary lime nodules; slight effervescence; mildly alkaline; abrupt wavy boundary.

C1—34 to 40 inches; gray (10YR 5/1) stratified sandy loam and loam; massive; few roots; few fine pores; 5 percent gravel; common fine white (5Y 8/1) shell fragments; strong effervescence; moderately alkaline; abrupt wavy boundary.

IIC2—40 to 60 inches; gray (10YR 5/1) coarse sand and gravelly sand; single grain; loose; few fine white (5Y 8/1) shell fragments; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 50 inches. The A horizon has hue of 10YR, value of 3 or 2, and chroma of 1 or 2. It is light clay loam, silty clay loam, or silt loam. The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. It is clay loam, silty clay loam, or silt loam. Reaction is neutral or mildly alkaline in the B2 horizon and is neutral to moderately alkaline in the C horizon.

Westland series

The Westland series consists of deep, very poorly drained, slowly permeable soils on broad terraces. These soils formed in 40 to 60 inches of loamy outwash underlain by sand and gravelly sand. Slopes range from 0 to 2 percent.

Westland soils are similar to Brookston and Sloan soils and are near Ockley and Sleeth soils. Brookston soils have a C horizon of loam till. Sloan soils have less gravel in the solum than Westland soils. Ockley and Sleeth soils have an ochric surface layer and are in a slightly higher position than Westland soils.

Typical pedon of Westland silty clay loam, in a cultivated area 1,325 feet west and 2,560 feet north of the southeast corner of sec. 27, T. 18 N., R. 4 E.:

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam; moderate medium granular structure; friable; few fine roots; 2 percent gravel; slightly acid; abrupt smooth boundary.

A12—9 to 16 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; friable; few fine roots; 2 percent gravel; slightly acid; clear smooth boundary.

B21tg—16 to 24 inches; dark gray (10YR 4/1) clay loam; common medium distinct yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; few fine roots; common thin discontinuous dark gray (10YR 4/1) clay films on faces of peds; few fine roots; 5 percent gravel; slightly acid; clear smooth boundary.

B22tg—24 to 38 inches; dark gray (5Y 4/1) clay loam; common medium and coarse distinct olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure; firm; common thin continuous dark gray (5Y 4/1) clay films on faces of peds; few old root channels and crayfish holes filled with very dark gray (10YR 3/1) silty clay loam and clay loam; 5 percent gravel; neutral; clear wavy boundary.

B23tg—38 to 42 inches; gray (10YR 5/1) gravelly clay loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak coarse subangular blocky structure; firm; 15 percent gravel; neutral; clear irregular boundary.

B3—42 to 46 inches; gray (10YR 5/1) gravelly sandy loam; weak coarse subangular blocky structure; friable; 15 percent gravel; neutral; clear wavy boundary.

IIC—46 to 60 inches; gray (10YR 5/1) gravelly sand and sand; single grain; loose; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 40 to 60 inches. The A horizon has hue of 10YR or 2.5Y, value of 3 or 2, and chroma of less than 2. It is loam, silt loam, silty clay loam, or clay loam. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of less than 2. The upper part of the B horizon is clay loam or silty clay loam and contains as

much as 10 percent gravel. The lower part of the B horizon is clay loam, sandy clay loam, or sandy loam or is gravelly analogs of these textures. The B horizon is mainly neutral or slightly acid, but thin subhorizons are commonly mildly alkaline and contain carbonates.

Whitaker series

The Whitaker series consists of deep, somewhat poorly drained, moderately permeable soils on terraces and slight rises on uplands. These soils formed in loamy outwash and in lacustrine sediment. Slopes range from 0 to 2 percent.

Whitaker soils are similar to Sleeth soils and are near Crosby and Patton soils. Sleeth soils have more gravel in the solum than Whitaker soils and have a horizon of sand and gravelly sand. Crosby soils have more clay in the B horizon than Whitaker soils and have a C horizon of loam till. Patton soils have a mollic surface layer.

Typical pedon of Whitaker loam, in a cultivated field 1,848 feet south and 350 feet west of the northeast corner of sec. 7, T. 18 N., R. 4 E.:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam; moderate coarse granular structure; friable; common fine roots; common fine and very fine pores; neutral; abrupt smooth boundary.

A2—9 to 13 inches; light brownish gray (10YR 6/2) loam; fine medium distinct dark yellowish brown (10YR 4/4) mottles; thick platy structure; friable; common fine roots; common fine pores; neutral; abrupt smooth boundary.

B21tg—13 to 18 inches; light brownish gray (2.5Y 6/2) clay loam; many medium distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; common fine roots; common fine and very fine pores; common continuous grayish brown (10YR 4/2) silt coatings on faces of peds; neutral; abrupt smooth boundary.

B22t—18 to 29 inches; dark yellowish brown (10YR 4/4) clay loam; many medium distinct grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) mottles; moderate fine and medium subangular blocky structure; firm; few fine roots; few very fine and fine pores; common continuous thin dark grayish brown (10YR 4/2) silt coatings on faces of peds; few thin patchy grayish brown (10YR 5/2) clay films on faces of peds; few black (N 2/0) accumulations of iron and manganese oxide; neutral; clear smooth boundary.

B23t—29 to 35 inches; dark yellowish brown (10YR 4/4) sandy clay loam; many medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; common continuous distinct thin grayish brown (10YR 4/2) clay films on faces of peds; 7 percent gravel; neutral; abrupt wavy boundary.

B24t—35 to 38 inches; dark yellowish brown (10YR 4/4) clay loam; many fine distinct grayish brown (10YR 5/2) mottles; moderate coarse subangular blocky structure; firm; few continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; 5 percent gravel; neutral; abrupt wavy boundary.

B3t—38 to 49 inches; mixed yellowish brown (10YR 5/4) and grayish brown (10YR 5/2) stratified fine sandy loam and loamy fine sand and thin clay lenses; weak coarse subangular blocky structure; friable; few continuous thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; neutral; abrupt wavy boundary.

C—49 to 60 inches; mixed yellowish brown (10YR 5/6), grayish brown (2.5Y 5/2), and light brownish gray (2.5Y 6/2) stratified very fine sand, fine sand, and silt loam; massive; loose; few light gray (5Y 6/1) silt coatings in channels; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 36 to 55 inches. The A horizon is dark grayish brown (10YR 4/2) or brown (10YR 5/3) silt loam or loam. The B horizon has hue of 10YR or 2.5Y, value of 4, 5, or 6, and chroma of 2 to 4. The upper part of the B horizon is silty clay loam or clay loam, and the lower part is sandy loam, loam, sandy clay loam, or clay loam. The B3 horizon is sandy clay loam, sandy loam, loam, or silt loam. Reaction in the most acid part of the B horizon is slightly acid to strongly acid. In the subhorizons reaction is slightly acid to mildly alkaline. The C horizon is stratified silty clay loam, loam, sandy loam, silt loam, or sand. Reaction is neutral to moderately alkaline, and carbonates are commonly present.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*5*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aqualf (*Aqu*, meaning water, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Ochraqualfs (*Ochr*, meaning light colored surface horizons, plus *aqualf*, the suborder of Alfisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great

group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Hapludalfs.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, mesic Typic Hapludalfs.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

In this section the major factors of soil formation are discussed and are related to the formation of soils in Hamilton County. The processes of soil formation are also discussed.

Factors of soil formation

Soil is produced by soil-forming processes that act on materials deposited or accumulated by geologic processes. The characteristics of a soil are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time during which the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in some cases, determines it almost entirely. Finally, time is needed to change parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Generally, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated mass in which a soil forms. The parent material of the soils in Hamilton County was deposited by glaciers or by glacial melt water. Some of the parent material was reworked and redeposited by water and wind. Glaciers covered the county as recently as about 20,000 years ago. Parent material determines the limits of the chemical and mineralogical composition of the soil. Although parent materials in Hamilton County have a similar glacial origin, their properties vary greatly, sometimes within a short distance, depending on the mode of deposition.

The soils in Hamilton County formed mainly in Wisconsin glacial till and glacial outwash. A thin layer of outwash was deposited over the till in some areas. Consequently, many of the soils on the till plain have outwash material in the solum. This outwash layer is not consistent either in depth or in continuity. Consequently, the influence of the outwash on soil formation varies within a short distance. In addition, some of the soils on the till plain have lacustrine material in the upper part of the solum. In small areas on the till plain and in glacial sluiceways, the soils formed entirely in lacustrine material. Soils along streams formed in recent alluvium. A thin layer of silty loess covers much of the northern and western parts of the county. The thickness of the loess is as much as 3 feet in some level areas.

In Hamilton County the preglacial landscape consisted of limestone and shale bedrock. The eastern part of the county was Silurian Age limestone, and the western part was Devonian Age shale. Several glaciers have covered the county, but the Wisconsin Glacier is the most recent and has had the most influence on soil formation. The thickness of the glacial drift is as much as 300 feet (*6*). The area where the glacial drift is thinnest is in the east-central part of the county. Some of the soils, for example, Milton and Randolph Variant soils, formed partly in material weathered from limestone. A limestone quarry in this area is an important source of crushed limestone.

Glacial till is material deposited directly by glaciers. Evidence of water action is minimal. The till consists of a mixture of particles of different sizes. Small pebbles in the glacial till have sharp corners which indicate a lack of water washing. The glacial till in Hamilton County is calcareous and firm. Its texture is sandy loam, loam, or clay loam. In many areas along White River, sand and gravel layers are in the till. Hennepin soils formed in glacial till. These soils typically are medium textured.

Outwash is material deposited by running water from melting glaciers. The size of the particles varies according to stream velocity. When the water slows, the coarser textured particles are deposited. Finer textured particles, for example, very fine sand, silt, and clay, can be carried by slowly moving water. Outwash in the northern part of

Hamilton County contains a considerable amount of dolomitic limestone. Because dolomite is weathered slowly, the outwash soils in this area are less acid than outwash soils in other parts of the county. In the east-central part of the county, the outwash contains limestone fragments that are coarser than those in the rest of the county. Outwash in Hamilton County is mainly along White River and the larger streams. A few other areas of outwash are scattered throughout the county. Most of these areas are small kames or eskers that are as much as 50 acres in size. Ockley soils formed in outwash deposits.

Lacustrine material is deposited from still glacial melt water. The coarser textured particles are deposited by moving water as outwash, but the finer textured particles, for example, very fine sand, silt, and clay, remain and settle in still water. Lacustrine deposits are silty or clayey in texture. In Hamilton County, soils that formed in lacustrine deposits typically are silty in texture. Patton soils formed in lacustrine materials.

Alluvial material is deposited by floodwaters of present streams in recent time. Texture of this material varies, depending on the velocity of the water. Ross and Shoals soils formed in alluvial material.

Organic material is made up of deposits of plant remains. After the glaciers withdrew from the survey area, water was left standing in depressions on outwash, lake, and till plains. Grasses and sedges grew around the edge of these lakes, and their remains fell to the bottom. Because of the wetness in these areas, the plant remains did not decompose. Later, white cedar and other water-tolerant trees grew in these areas. As these trees died, their remains were added to the organic accumulation.

The lakes were eventually filled with organic material and developed into areas of muck and peat. In some of these areas the plant remains subsequently decomposed. In other areas the material has changed little since the time of deposition. Houghton soils formed in organic material.

Loess is fine grained material that consists mainly of silt-sized particles. The loess in Hamilton County was carried by wind from western sources, possibly the Wabash River Valley. Loess is mostly chemically and physically homogenous. The loess in Hamilton County is mostly on large flats.

Plant and animal life

Plants have been the principal organisms to influence soil formation in the survey area. However, bacteria, fungi, earthworms, and the activities of man have also been important. The chief contribution of plant and animal life to soil formation is the addition of organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends on the kind of plants that grow. Plant remains accumulate on the surface, decay, and eventually become organic matter. Plant roots provide channels for downward movement of water through the soil, and they also add organic matter as the plants decay. Bacteria in the soil help to break down organic matter into nutrients that can be used by growing plants.

Generally, the well drained soils on uplands, for example, Miami and Ockley soils, were covered with sugar maple, ash, oak, hickory, and poplar. The tree cover on wet soils consisted primarily of gum, elm, and oak. A few wet soils also had sphagnum and other mosses, which contributed substantially to the accumulation of organic matter. The Brookston and Patton soils formed under wet conditions and contain a considerable amount of organic matter. The soils that formed under dominantly forest vegetation generally have less accumulated organic matter than soils that formed under dominantly grass vegetation.

Climate

Climate is an important factor in soil formation. It determines the kind of plant and animal life on and in the soil. It also determines the amount of water available for weathering of minerals and the transporting of soil materials. Climate, through its influence on soil temperature, determines the rate of chemical reactions in the soil.

The climate of Hamilton County is cool and humid and probably was similar when the soils formed. Because the climate is nearly uniform throughout the county, differences among the soils cannot be explained by differences in climate alone. Detailed information on the climate of the county is given in the section "General nature of the county."

Relief

Relief, or topography, has a marked influence on the soils in Hamilton County. It influences natural drainage, erosion, plant cover, and soil temperature. In Hamilton County slopes range from 0 to 50 percent. The soils range from well drained on the ridgetops to very poorly drained in depressions.

Relief influences soil formation by affecting runoff and drainage. Drainage, through its effect on aeration of the soil, determines the color of the soil. Runoff is greatest on the steeper slopes. In many low areas water ponds temporarily. Water and air move freely through most of the well drained soils and move slowly through most of the very poorly drained soils. Iron and aluminum compounds influence the color of most soils. These compounds are brightly colored and are oxidized in well drained soils. Poorly aerated soils commonly are dull gray in color and are mottled, because the compounds are in a reduced state. Ockley soils are well drained and well aerated, and Patton soils are poorly drained and poorly aerated.

Time

A long time is required for soils to develop distinct soil horizons from parent material. The differences in length of time that the parent material has been in place are

commonly reflected in the degree of development of the soil profile. Some soils form rapidly, others form slowly.

The soils in Hamilton County range from young to mature. The glacial deposits in which many of the soils formed have been exposed to soil-forming factors for enough time for distinct horizons to develop in the profile. However, some soils, which are forming in recent alluvial sediment, have not been in place for enough time for distinct horizons to develop.

Genesee soils are young and formed in alluvial material. Miami and Crosby soils are older soils and formed in calcareous material, but they are leached of lime to a depth of 20 to 40 inches. Patton soils formed in sediment under glacial lake water and were protected from leaching for a long time because they were submerged. These soils generally are leached to a depth of 20 to 40 inches, but in a few areas they are leached to a depth of only 12 inches. In contrast to Patton soils, Whitaker soils formed above water and were subject to leaching for a longer time. Whitaker soils commonly are leached to a depth of more than 40 inches.

Processes of soil formation

Several processes have been involved in the formation of soils in Hamilton County. These processes are the accumulation of organic matter; the solution, transfer, and removal of calcium carbonate and bases; and the formation and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in horizon differentiation.

Some organic matter has accumulated in the surface layer in all of the soils in the county. The organic-matter content is low in some of the soils and is high in others. Generally, the soils that have much organic matter, for example, Brookston and Patton soils, have a thick, black surface layer.

Carbonates and bases have been leached from the upper horizons in nearly all of the soils in the county. This leaching is generally believed to precede the translocation of silicate clay minerals. Almost all of the carbonates and some of the bases have been leached from the A and B horizons in well drained soils. Some leaching occurs even in very wet soils and is indicated by the absence of carbonates and by an acid soil reaction. Leaching of wet soils occurs slowly because of a high water table or the slow movement of water through the profile.

Clay particles accumulate in pores and other voids and form a film on surfaces along which water moves. Leaching of bases and translocation of silicate clays are particularly important processes of horizon differentiation in the soils in the county. For example, translocated silicate clay has accumulated as clay films in the B2t horizon in Miami soils.

The reduction and transfer of iron, or gleying, has occurred in all of the very poorly drained to somewhat poorly drained soils in the county. In the naturally wet soils, this process has been significant in horizon differentiation. The gray color of the subsoil indicates the redistribution of iron oxides. The reduction is commonly accompanied by the transfer of some iron from upper horizons to lower horizons or by the removal of iron from the profile. Mottles, which are in some horizons, indicate the segregation of iron.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, subsurface. Removal of excess ground water through buried drains installed within the soil profile. The drains collect the water and convey it to a gravity or pump outlet.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are interbedded or laminated.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Illustrations

Figure 1.—The dark colored areas are Brookston soils, and the light colored areas are Crosby soils.

Figure 2.—Brookston and Crosby soils surround Patton soils that are in the lowest part of the depression. The original surface layer of the Patton soils has been covered by an overwash of light colored soil material.

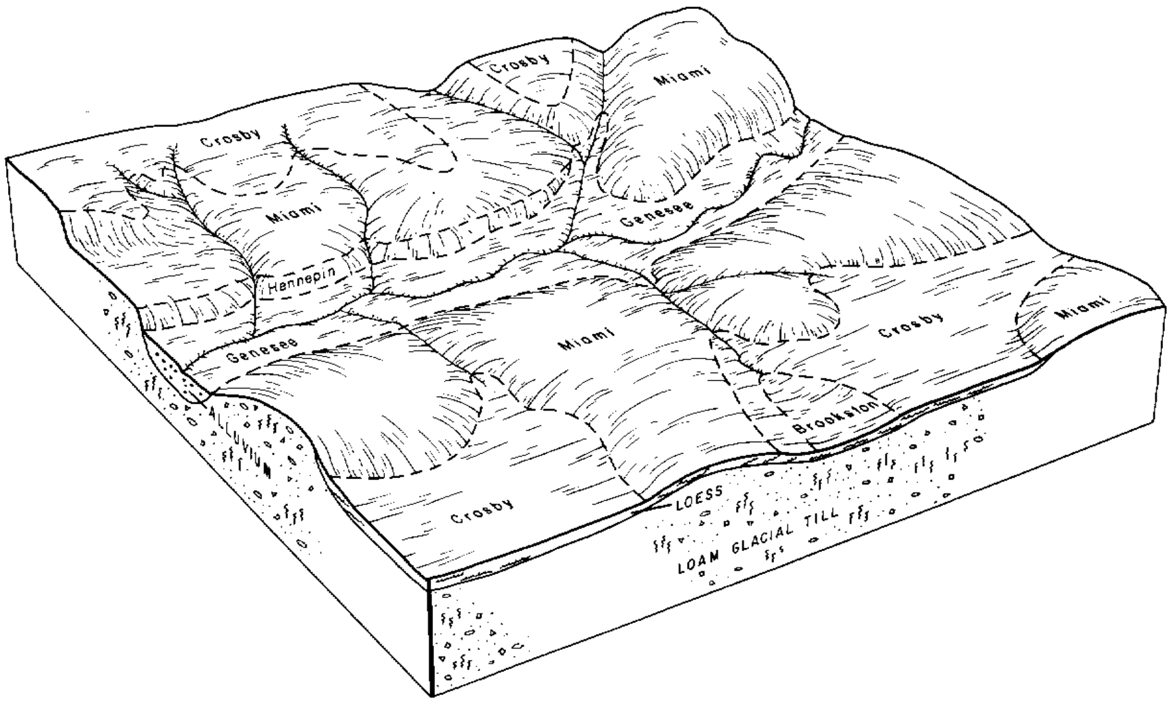

Figure 3.—General pattern of soils and underlying material in the Miami-Crosby map unit.

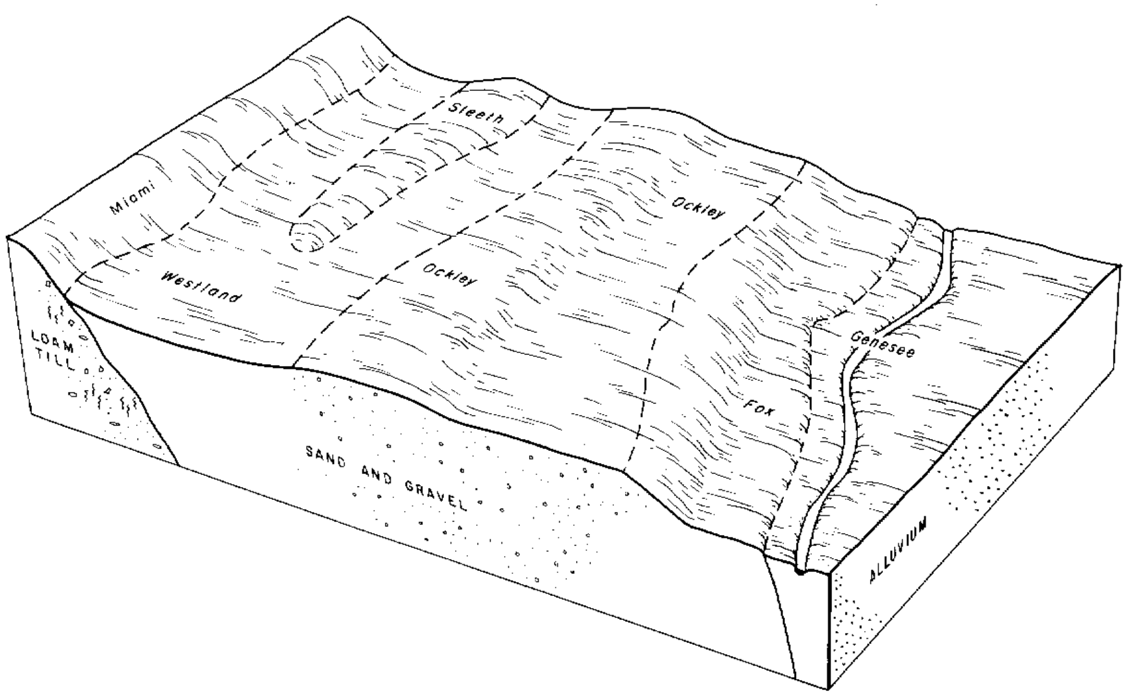

Figure 4.—General pattern of soils and underlying material in the Ockley-Westland-Fox map unit.

Figure 5.—Nearly level Westland soils (above) are on the terrace in the foreground. Hennepin soils are on a typical upland break in the background.

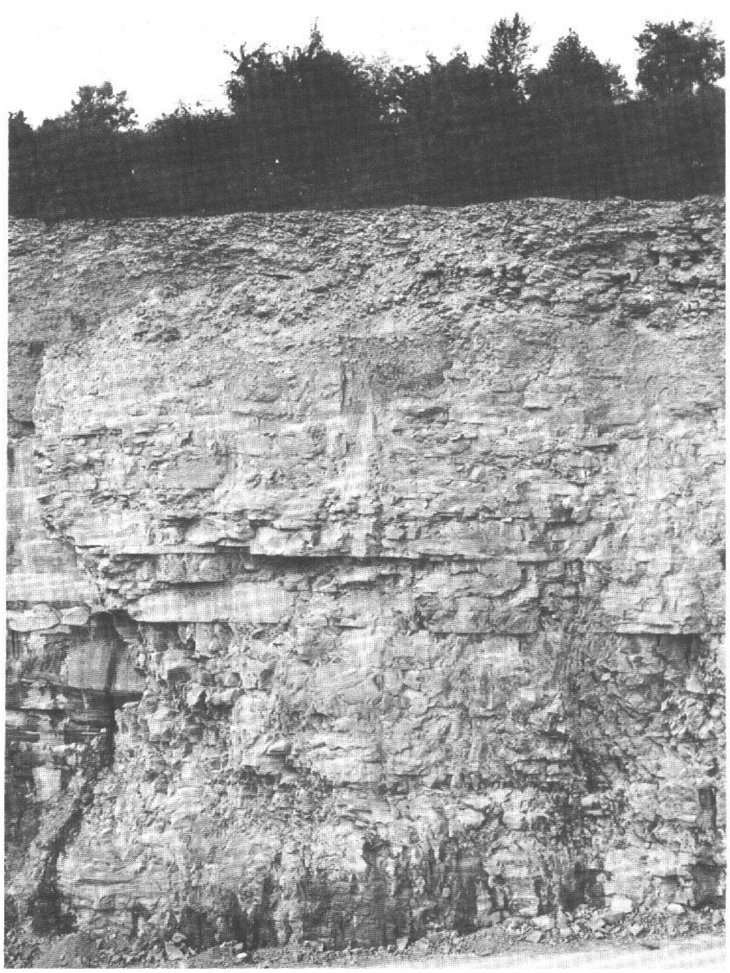

Figure 6.—Silurian Age limestone (at left) is exposed in this quarry. Thickness of the limestone visible in the photograph is about 25 feet. Milton Variant and Randolph Variant soils formed in loamy outwash that is underlain by this limestone.

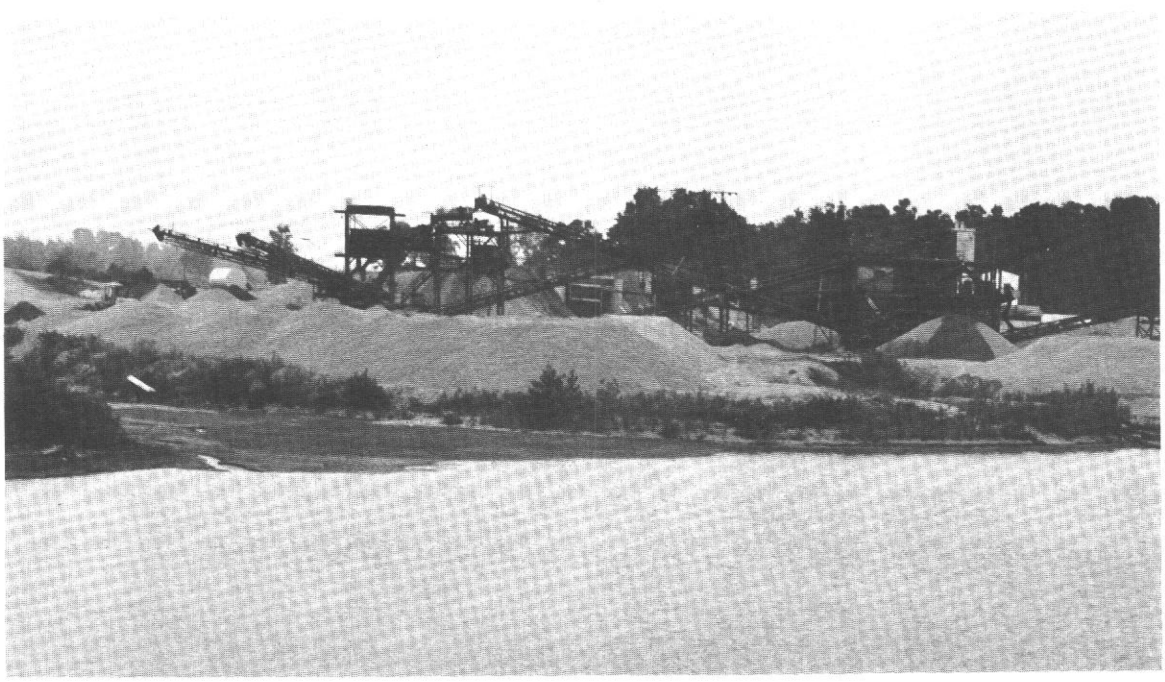

Figure 7.—This gravel pit is in an area of Ockley soils.

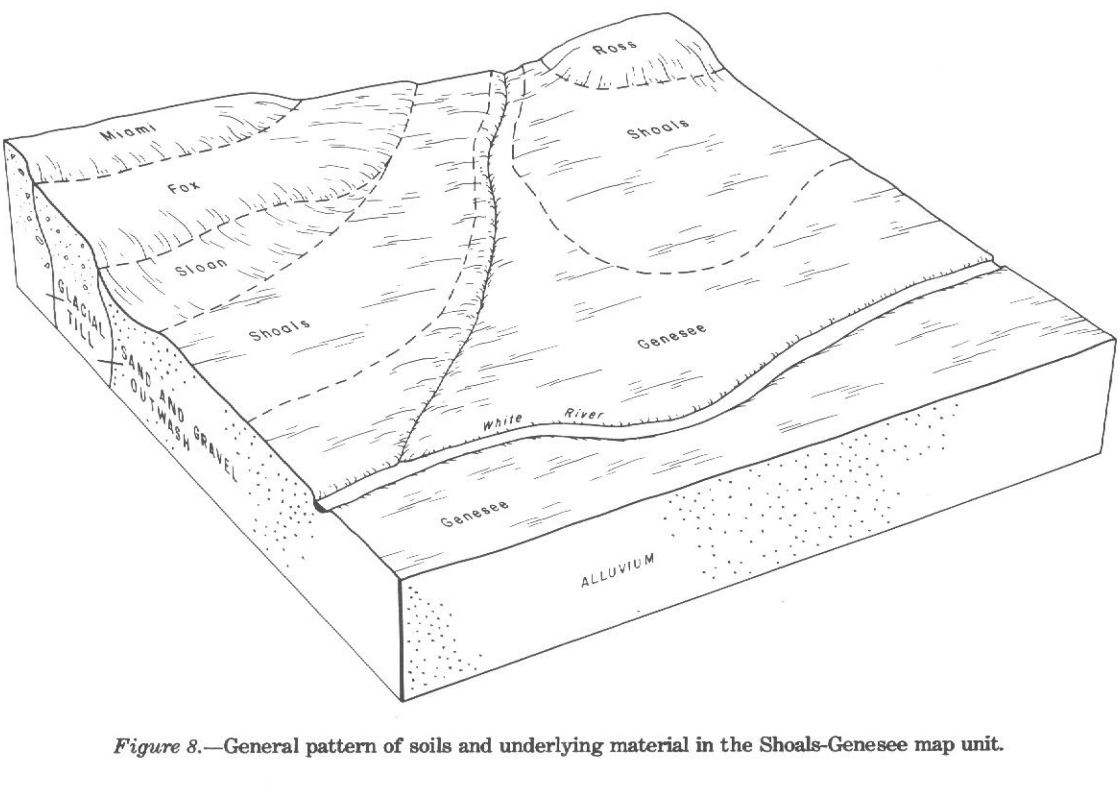

Figure 8.—General pattern of soils and underlying material in the Shoals-Genesee map unit.

Figure 9.—Woodland in an area of Miami silt loam, 0 to 2 percent slopes.

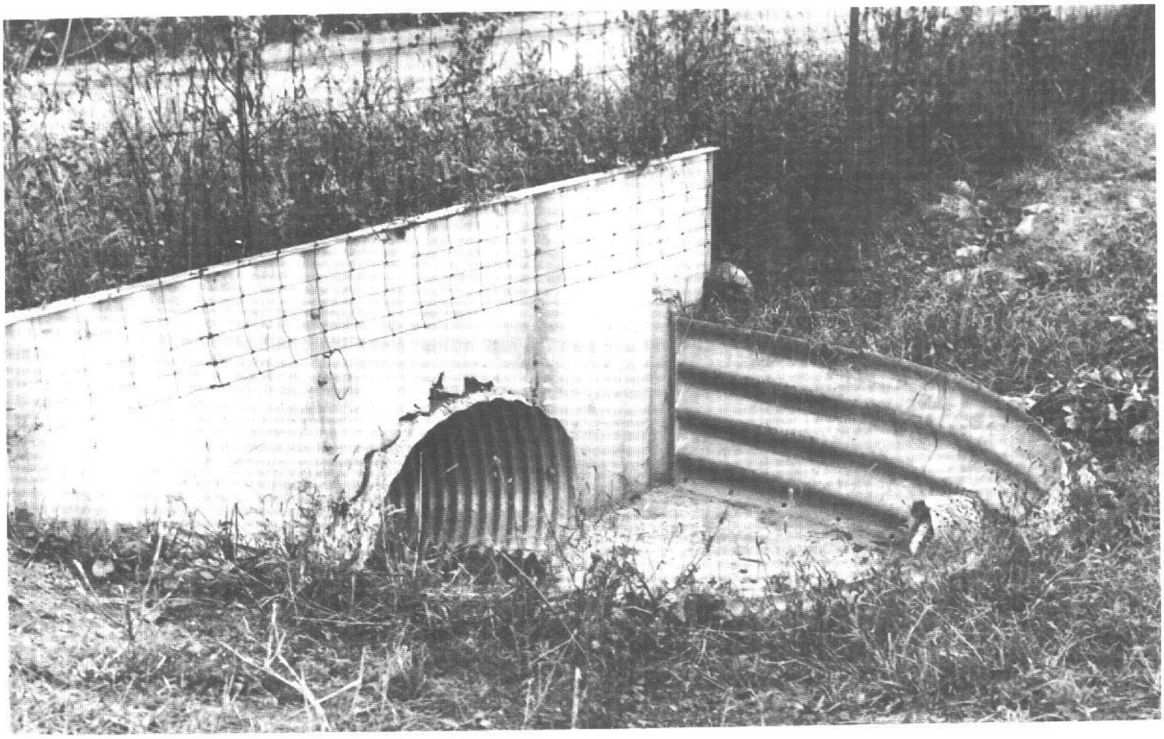

Figure 10.—This grade stabilization structure helps to prevent ditchbank erosion in this area of Shoals silt loam.

Figure 11.—This tree in an area of Houghton muck has been uprooted by windthrow.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data recorded at Whitestown (temperature) and Noblesville (precipitation)]

Month	Temperature				Precipitation				
			2 years in 10 will have at least 5 days with--			1 year in 10 will have--			
	Average daily maximum	Average daily minimum	Maximum temperature equal to or higher than--	Minimum temperature equal to or lower than--	Average monthly total	Less than--	More than--	Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover of 1 inch or more
	°F	°F	°F	°F	In	In	In		In
January---	35	18	58	- 7	2.6	0.7	4.7	11	4.0
February--	39	21	59	- 1	2.2	0.6	3.7	7	2.8
March-----	49	29	72	10	3.1	1.4	5.9	2	2.6
April-----	63	41	81	24	4.0	1.6	7.0	(1/)	1.8
May-------	74	50	87	33	4.2	1.7	7.0	0	0
June------	83	59	93	44	4.1	1.8	6.6	0	0
July------	86	61	94	50	3.7	1.6	7.0	0	0
August----	84	59	93	46	2.9	1.4	5.4	0	0
September-	78	52	91	36	2.7	1.1	6.3	0	0
October---	66	42	82	26	2.4	0.8	4.2	0	0
November--	51	31	70	13	2.9	1.1	4.5	1	2.6
December--	38	21	60	0	2.4	0.8	5.7	7	3.1
Year---	62	40	96 2/	- 9 3/	37.2	30.9	46.9	28	3.3

1/Less than 1/2 day.
2/Average annual highest maximum.
3/Average annual lowest minimum.

TABLE 2.--PROBABILITIES OF LAST FREEZING TEMPERATURES IN SPRING AND FIRST IN FALL

[Data recorded at Whitestown]

Probability	Dates for given probability and temperature of--				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than--	Mar. 27	Apr. 7	Apr. 19	May 4	May 15
2 years in 10 later than--	Mar. 21	Apr. 1	Apr. 13	Apr. 28	May 11
5 years in 10 later than--	Mar. 10	Mar. 20	Mar. 31	Apr. 16	May 2
Fall:					
1 year in 10 earlier than--	Nov. 9	Oct. 30	Oct. 22	Oct. 8	Sept. 25
2 years in 10 earlier than--	Nov. 15	Nov. 6	Oct. 26	Oct. 13	Sept. 30
5 years in 10 earlier than--	Nov. 28	Nov. 17	Nov. 4	Oct. 25	Oct. 10

TABLE 3.--POTENTIALS AND LIMITATIONS OF MAP UNITS ON THE GENERAL SOIL MAP FOR SPECIFIED USES

Map unit	Extent of area	Cultivated farm crops	Special crops	Woodland	Urban uses	Intensive recreation areas	Extensive recreation areas
	Pct						
1. Crosby-Brookston	59	Good	Fair: wetness.	Fair: wetness.	Poor: wetness.	Poor: wetness.	Poor: wetness.
2. Miami-Crosby	27	Fair: erosion, wetness.	Fair	Good	Fair: wetness, slope.	Fair: wetness, slope.	Fair: wetness.
3. Ockley-Westland-Fox	9	Good	Good	Good	Good	Good	Good.
4. Shoals-Genesee	5	Fair: flooding.	Poor: flooding.	Good	Poor: flooding.	Poor: flooding.	Fair: flooding.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Br	Brookston silty clay loam	62,510	24.4
CrA	Crosby silt loam, 0 to 3 percent slopes	93,764	36.5
FnA	Fox loam, 0 to 2 percent slopes	1,402	0.5
FnB2	Fox loam, 2 to 6 percent slopes, eroded	1,465	0.6
FxC3	Fox clay loam, 8 to 18 percent slopes, severely eroded	1,099	0.4
Ge	Genesee silt loam	3,295	1.3
HeF	Hennepin loam, 18 to 50 percent slopes	1,960	0.8
Ho	Houghton muck	321	0.1
MmA	Miami silt loam, 0 to 2 percent slopes	7,718	3.0
MmB2	Miami silt loam, 2 to 6 percent slopes, eroded	29,379	11.4
MmC2	Miami silt loam, 6 to 12 percent slopes, eroded	3,923	1.5
MmD2	Miami silt loam, 12 to 18 percent slopes, eroded	1,311	0.5
MoC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	3,496	1.4
MoD3	Miami clay loam, 12 to 18 percent slopes, severely eroded	946	0.4
MxA	Milton Variant silt loam, 0 to 2 percent slopes	701	0.3
NnA	Nineveh loam, 0 to 2 percent slopes	288	0.1
OcA	Ockley silt loam, 0 to 2 percent slopes	8,278	3.2
OcB2	Ockley silt loam, 2 to 6 percent slopes, eroded	1,225	0.5
Or	Orthents	1,044	0.4
Pa	Palms muck	217	0.1
Pn	Patton silty clay loam	11,158	4.3
Ps	Patton silty clay loam, limestone substratum	501	0.2
Pt	Pits	1,017	0.4
Ra	Randolph Variant silt loam	336	0.1
Ro	Ross loam	656	0.3
Sh	Shoals silt loam	6,775	2.6
St	Sleeth loam	931	0.4
Sx	Sloan silty clay loam, sandy substratum	1,273	0.5
We	Westland silty clay loam	4,886	1.9
Wh	Whitaker loam	1,007	0.4
	Water areas	3,758	1.5
	Total	256,640	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. The estimates were made in 1976. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Winter wheat	Grass-legume hay	Tall fescue
	Bu	Bu	Bu	Ton	AUM*
Br------------------------ Brookston	145	45	45	4.8	9.6
CrA----------------------- Crosby	115	42	45	3.4	6.8
FnA----------------------- Fox	90	32	45	3.0	6.0
FnB2---------------------- Fox	85	30	42	3.0	6.0
FxC3---------------------- Fox	70	26	35	2.3	4.6
Ge------------------------ Genesee	100	42	48	3.0	8.0
HeF----------------------- Hennepin	---	---	---	1.9	3.8
Ho------------------------ Houghton	90	34	---	4.3	8.6
MmA----------------------- Miami	110	38	50	3.6	7.2
MmB2---------------------- Miami	105	37	47	3.4	6.8
MmC2---------------------- Miami	90	33	43	3.1	6.2
MmD2---------------------- Miami	70	25	35	2.6	5.2
MoC3---------------------- Miami	75	25	35	3.0	6.0
MoD3---------------------- Miami	---	---	---	2.5	5.0
MxA----------------------- Milton Variant	85	29	38	2.5	5.0
NnA----------------------- Nineveh	100	35	51	3.3	6.6
OcA----------------------- Ockley	110	38	51	3.6	7.2
OcB2---------------------- Ockley	105	37	47	3.4	6.8
Pa------------------------ Palms	120	42	---	4.3	8.6
Pn------------------------ Patton	140	45	45	4.8	9.6
Ps------------------------ Patton	125	40	40	4.0	8.0

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Winter wheat	Grass-legume hay	Tall fescue
	Bu	Bu	Bu	Ton	AUM*
Pt**. Pits					
Ra. Randolph Variant	105	35	40	3.5	6.5
Ro. Ross	130	45	50	5.5	8.8
Sh. Shoals	100	42	33	3.0	8.0
St. Sleeth	120	42	48	4.0	8.0
Sx. Sloan	95	42	45	4.6	9.2
We. Westland	140	45	45	4.6	9.2
Wh. Whitaker	125	42	45	4.1	8.2

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
Br------------------ Brookston	2w	Slight	Severe	Severe	Moderate	Pin oak White oak Sweetgum Northern red oak	85 75 90 75	Eastern white pine, baldcypress, Norway spruce, red maple, white ash, sweetgum.
CrA----------------- Crosby	3o	Slight	Slight	Slight	Slight	White oak Pin oak Yellow-poplar Sweetgum Northern red oak	75 85 85 80 75	Eastern white pine, baldcypress, white ash, red maple, yellow-poplar, American sycamore.
FnA, FnB2, FxC3---- Fox	2o	Slight	Slight	Slight	Slight	Northern red oak White oak Sugar maple	80 --- ---	Yellow-poplar, white ash, eastern white pine, red pine, black locust.
Ge------------------ Genesee	1o	Slight	Slight	Slight	Slight	Yellow-poplar	100	Eastern white pine, black walnut, yellow-poplar, black locust.
HeF----------------- Hennepin	1r	Severe	Severe	Slight	Slight	Northern red oak White oak	85 ---	Northern red oak, white oak, green ash, black walnut, eastern white pine, red pine, eastern redcedar.
Ho------------------ Houghton	4w	Slight	Severe	Severe	Severe	Red maple Silver maple White ash Quaking aspen	46 --- --- ---	
MmA, MmB2, MmC2, MmD2, MoC3, MoD3-- Miami	1o	Slight	Slight	Slight	Slight	White oak Yellow-poplar Sweetgum	90 98 76	Eastern white pine, red pine, white ash, yellow-poplar, black walnut, black locust.
MxA----------------- Milton Variant	2o	Slight	Slight	Slight	Slight	Northern red oak White ash Yellow-poplar Black walnut Black cherry	80 --- 95 --- ---	Eastern white pine, yellow-poplar, black walnut.
NnA----------------- Nineveh	1o	Slight	Slight	Slight	Slight	White oak Yellow-poplar Sweetgum	90 98 76	Eastern white pine, red pine, black walnut, yellow-poplar, white ash.
OcA, OcB2----------- Ockley	1o	Slight	Slight	Slight	Slight	White oak Northern red oak Yellow-poplar Sweetgum	90 90 98 76	Eastern white pine, red pine, white ash, yellow-poplar, black walnut, black locust.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Important trees	Site index	
Pa: Palms	4w	Slight	Severe	Severe	Severe	Red maple Silver maple White ash Quaking aspen	46 --- --- ---	
Pn, Ps: Patton	2w	Slight	Severe	Moderate	Moderate	Pin oak White oak Sweetgum Northern red oak	85 75 80 75	Eastern white pine, baldcypress, Norway spruce, red maple, white ash, sweetgum.
Ra: Randolph Variant	3o	Slight	Slight	Slight	Slight	Northern red oak Pin oak Yellow-poplar Sweetgum White oak	75 85 85 80 75	Eastern white pine, baldcypress, white ash, red maple, yellow-poplar, American sycamore.
Ro: Ross	1o	Slight	Slight	Slight	Slight	Northern red oak Yellow-poplar Sugar maple	85 95 85	Eastern white pine, black walnut, white ash, Norway spruce, yellow-poplar.
Sh: Shoals	2o	Slight	Slight	Slight	Slight	Pin oak Sweetgum Yellow-poplar Virginia pine Eastern cottonwood White ash	90 85 90 90 --- ---	Sweetgum, red maple, swamp chestnut oak, pin oak, yellow-poplar.
St: Sleeth	3o	Slight	Slight	Slight	Slight	Pin oak Yellow-poplar Sweetgum White oak	85 85 80 75	Eastern white pine, baldcypress, white ash, red maple, yellow-poplar, American sycamore.
Sx: Sloan	2w	Slight	Severe	Severe	Severe	Pin oak Red maple Swamp white oak White ash Sweetgum	85 --- --- --- 90	Eastern white pine, baldcypress, Norway spruce, red maple, white ash, sweetgum.
We: Westland	2w	Slight	Severe	Severe	Severe	Pin oak Sweetgum White oak	85 90 75	Eastern white pine, baldcypress, Norway spruce, red maple, white ash, sweetgum.
Wh: Whitaker	3o	Slight	Slight	Slight	Slight	White oak Pin oak Yellow-poplar Sweetgum Northern red oak	75 85 85 80 75	Eastern white pine, baldcypress, white ash, red maple, yellow-poplar, American sycamore.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Br-----------------Brookston	Gray dogwood, dwarf purple willow.	Redosier dogwood, Amur honeysuckle, silky dogwood.	Northern white-cedar, medium purple willow, tall purple willow, Siberian crabapple.	---	Green ash, Lombardy poplar.
CrA----------------Crosby	Cutleaf stag sumac	Blackhaw, arrowwood, rose-of-sharon, Amur honeysuckle, Amer cranberrybush, autumn-olive.	---	American basswood, Norway spruce, white spruce.	Eastern white pine.
FnA, FnB2, FxC3---Fox	---	Autumn-olive, Amur honeysuckle, blackhaw, shadblow serviceby, Amer cranberrybush, cornelian cherry dogwd.	---	Norway spruce, white spruce, American basswood.	Eastern white pine.
Ge-----------------Genesee	Mockorange--------	European burningbush, blackhaw, late lilac, Amur honeysuckle, shadblow serviceby, Amer cranberrybush, autumn-olive.	Eastern hemlock---	Norway spruce-----	Eastern white pine, honeylocust.
HeF----------------Hennepin	---	European burningbush, blackhaw, late lilac, Amur honeysuckle, autumn-olive.	Eastern hemlock---	Norway spruce-----	Honeylocust, eastern white pine.
Ho-----------------Houghton	Gray dogwood, dwarf purple willow.	Amur honeysuckle, redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	Lombardy poplar.
MmA, MmB2, MmC2, MmD2, MoC3, MoD3-Miami	---	Blackhaw, late lilac, Amur honeysuckle, shadblow serviceby, winged euonymus, Amer cranberrybush, autumn-olive.	Eastern hemlock, European burningbush.	Norway spruce-----	Eastern white pine, honeylocust.
MxA----------------Milton Variant	Mockorange--------	European burningbush, blackhaw, late lilac, Amur honeysuckle, shadblow serviceby, Amer cranberrybush, autumn-olive.	Eastern hemlock---	Norway spruce-----	Honeylocust, eastern white pine.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
NnA----------------- Nineveh	Mockorange---------	European burningbush, blackhaw, late lilac, Amur honeysuckle, shadblow serviceby, Amer cranberrybush, autumn-olive.	Eastern hemlock---	Norway spruce-----	Eastern white pine, honeylocust.
OcA, OcB2--------- Ockley	---	Autumn-olive, Amer cranberrybush, late lilac, Tatarian honeysuckle.	White spruce------	Eastern white pine, Norway spruce.	Carolina poplar.
Or*. Orthents					
Pa----------------- Palms	Gray dogwood, dwarf purple willow.	Northern white-cedar, Amur honeysuckle, silky dogwood.	Tall purple willow, medium purple willow, redosier dogwood.	---	Lombardy poplar.
Pn----------------- Patton	---	Silky dogwood, redosier dogwood.	Amur maple, northern white-cedar, tall purple willow, medium purple willow.	---	American sycamore, Lombardy poplar.
Ps----------------- Patton	Gray dogwood, dwarf purple willow.	Amur honeysuckle, redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	Lombardy poplar.
Pt*. Pits					
Ra----------------- Randolph Variant	Cutleaf stag sumac	Blackhaw, arrowwood, cornelian cherry dogwd, rose-of-sharon, Amur honeysuckle, Amer cranberrybush, autumn-olive.	---	American basswood, Norway spruce, white spruce.	Eastern white pine.
Ro----------------- Ross	Mockorange---------	European burningbush, blackhaw, late lilac, Amur honeysuckle, shadblow serviceby, Amer cranberrybush, autumn-olive.	Eastern hemlock---	Norway spruce-----	Honeylocust, eastern white pine.
Sh----------------- Shoals	Gray dogwood, dwarf purple willow.	Redosier dogwood, silky dogwood, Amur honeysuckle.	Northern white-cedar, medium purple willow, tall purple willow.	---	Lombardy poplar.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
St----------------- Sleeth	Cutleaf stag sumac	Blackhaw, arrowwood, cornelian cherry dogwd, rose-of-sharon, Amur honeysuckle, Amer cranberrybush, autumn-olive.	White spruce------	American basswood, Norway spruce.	Eastern white pine.
Sx----------------- Sloan	Gray dogwood, dwarf purple willow.	Amur honeysuckle, redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	Lombardy poplar.
We----------------- Westland	Gray dogwood, dwarf purple willow.	Amur honeysuckle, redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	Lombardy poplar.
Wh----------------- Whitaker	---	Autumn-olive, Amur honeysuckle, Amer cranberrybush, blackhaw, shadblow serviceby, arrowwood, cornelian cherry dogwd, rose-of-sharon.	---	Norway spruce, white spruce, American basswood.	Eastern white pine.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Br----------------- Brookston	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.
CrA---------------- Crosby	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: frost action, low strength.
FnA---------------- Fox	Severe: cutbanks cave.	Slight-----------	Slight-----------	Slight------------	Moderate: shrink-swell.
FnB2--------------- Fox	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Moderate: shrink-swell.
FxC3--------------- Fox	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, shrink-swell.
Ge----------------- Genesee	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
HeF---------------- Hennepin	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
Ho----------------- Houghton	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
MmA---------------- Miami	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
MmB2--------------- Miami	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.
MmC2--------------- Miami	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
MmD2--------------- Miami	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
MoC3--------------- Miami	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
MoD3--------------- Miami	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.
MxA---------------- Milton Variant	Severe: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.
NnA---------------- Nineveh	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.	Severe: low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
OcA----------------- Ockley	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
OcB2---------------- Ockley	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, slope, low strength.	Severe: low strength.
Or*. Orthents					
Pa----------------- Palms	Severe: wetness, excess humus, floods.	Severe: wetness, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.
Pn----------------- Patton	Severe: wetness.	Severe: wetness, low strength, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, frost action, low strength.
Ps----------------- Patton	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.
Pt*. Pits					
Ra----------------- Randolph Variant	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: low strength, wetness, frost action.
Ro----------------- Ross	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Sh----------------- Shoals	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, frost action.
St----------------- Sleeth	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.
Sx----------------- Sloan	Severe: wetness, floods, cutbanks cave.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: wetness, floods, frost action.
We----------------- Westland	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: low strength, wetness, floods.
Wh----------------- Whitaker	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Br------------------- Brookston	Severe: wetness, percs slowly, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
CrA------------------ Crosby	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey.
FnA, FnB2------------ Fox	Slight-----------	Severe: seepage.	Severe: seepage.	Slight-----------	Fair: thin layer.
FxC3----------------- Fox	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Moderate: slope.	Fair: thin layer, slope.
Ge------------------- Genesee	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
HeF------------------ Hennepin	Severe: slope, percs slowly.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope, area reclaim.
Ho------------------- Houghton	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: hard to pack, wetness.
MmA------------------ Miami	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
MmB2----------------- Miami	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
MmC2----------------- Miami	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: slope, too clayey.
MmD2----------------- Miami	Severe: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
MoC3----------------- Miami	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: slope, too clayey.
MoD3----------------- Miami	Severe: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
MxA------------------ Milton Variant	Severe: depth to rock.	Moderate: seepage, depth to rock.	Severe: depth to rock.	Slight-----------	Poor: too clayey.
NnA------------------ Nineveh	Slight-----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy.
OcA, OcB2------------ Ockley	Slight-----------	Severe: seepage.	Severe: seepage.	Slight-----------	Fair: too clayey.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Or*. Orthents					
Pa----------------- Palms	Severe: wetness, floods, subsides.	Severe: wetness, excess humus, seepage.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, seepage.	Poor: excess humus, wetness.
Pn----------------- Patton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Ps----------------- Patton	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, depth to rock.	Severe: wetness.	Poor: wetness.
Pt*. Pits					
Ra----------------- Randolph Variant	Severe: depth to rock, wetness, percs slowly.	Severe: wetness.	Severe: depth to rock, wetness.	Severe: wetness.	Fair: too clayey, small stones.
Ro----------------- Ross	Severe: floods.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Good.
Sh----------------- Shoals	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
St----------------- Sleeth	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Fair: too clayey.
Sx----------------- Sloan	Severe: wetness, floods, percs slowly.	Severe: wetness, floods, seepage.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Poor: wetness.
We----------------- Westland	Severe: wetness, floods, percs slowly.	Severe: seepage, wetness, floods.	Severe: seepage, wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Wh----------------- Whitaker	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness, seepage.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Br-------------------- Brookston	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
CrA------------------- Crosby	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
FnA, FnB2------------- Fox	Good-----------------	Good-----------------	Good-----------------	Fair: thin layer.
FxC3------------------ Fox	Good-----------------	Good-----------------	Good-----------------	Fair: too clayey, slope.
Ge-------------------- Genesee	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
HeF------------------- Hennepin	Poor: low strength, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope, area reclaim.
Ho-------------------- Houghton	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
MmA, MmB2------------- Miami	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
MmC2------------------ Miami	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
MmD2------------------ Miami	Fair: low strength, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
MoC3------------------ Miami	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
MoD3------------------ Miami	Fair: low strength, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
MxA------------------- Milton Variant	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
NnA------------------- Nineveh	Good-----------------	Good-----------------	Good-----------------	Fair: thin layer.
OcA, OcB2------------- Ockley	Poor: low strength.	Good-----------------	Good-----------------	Fair: thin layer.
Or*. Orthents				
Pa-------------------- Palms	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
Pn-------------------- Patton	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ps----------------- Patton	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Pt*. Pits				
Ra----------------- Randolph Variant	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, small stones.
Ro----------------- Ross	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Sh----------------- Shoals	Poor: frost action.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
St----------------- Sleeth	Poor: low strength.	Good----------------	Good----------------	Fair: thin layer.
Sx----------------- Sloan	Poor: low strength, wetness.	Good----------------	Poor: excess fines.	Poor: wetness.
We----------------- Westland	Poor: wetness, low strength.	Good----------------	Good----------------	Poor: wetness.
Wh----------------- Whitaker	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Br-----------------Brookston	Favorable------	Wetness--------	Slow refill----	Floods, frost action.	Not needed-----	Wetness.
CrA---------------Crosby	Favorable------	Piping, wetness.	Slow refill----	Percs slowly---	Not needed-----	Wetness, percs slowly.
FnA, FnB2, FxC3---Fox	Seepage--------	Low strength, piping.	No water-------	Not needed-----	Piping, rooting depth.	Rooting depth.
Ge----------------Genesee	Seepage--------	Piping---------	No water-------	Not needed-----	Not needed-----	Favorable.
HeF---------------Hennepin	Slope----------	Favorable------	No water-------	Not needed-----	Slope----------	Slope.
Ho----------------Houghton	Seepage--------	Excess humus, low strength.	Favorable------	Poor outlets, frost action.	Not needed-----	Wetness.
MmA---------------Miami	Seepage--------	Favorable------	No water-------	Not needed-----	Not needed-----	Erodes easily.
MmB2--------------Miami	Favorable------	Favorable------	No water-------	Not needed-----	Complex slope	Erodes easily.
MmC2--------------Miami	Slope----------	Favorable------	No water-------	Not needed-----	Complex slope	Slope, erodes easily.
MmD2--------------Miami	Slope----------	Favorable------	No water-------	Not needed-----	Slope----------	Slope, erodes easily.
MoC3--------------Miami	Slope----------	Favorable------	No water-------	Not needed-----	Complex slope	Slope, erodes easily.
MoD3--------------Miami	Slope----------	Favorable------	No water-------	Not needed-----	Slope----------	Slope, erodes easily.
MxA---------------Milton Variant	Depth to rock	Thin layer, hard to pack.	No water-------	Not needed-----	Not needed-----	Favorable.
NnA---------------Nineveh	Seepage--------	Seepage--------	No water-------	Not needed-----	Not needed-----	Favorable.
OcA---------------Ockley	Seepage--------	Favorable------	No water-------	Not needed-----	Not needed-----	Erodes easily.
OcB2--------------Ockley	Seepage--------	Favorable------	No water-------	Not needed-----	Favorable------	Erodes easily.
Or*. Orthents						
Pa----------------Palms	Seepage--------	Excess humus, wetness.	Favorable------	Floods, frost action.	Not needed-----	Wetness.
Pn----------------Patton	Seepage--------	Wetness--------	Slow refill----	Frost action---	Not needed-----	Wetness.
Ps----------------Patton	Seepage, depth to rock.	Wetness, thin layer.	Depth to rock	Frost action---	Not needed-----	Wetness.
Pt*. Pits						
Ra----------------Randolph Variant	Depth to rock	Hard to pack, wetness.	Slow refill----	Frost action---	Not needed-----	Wetness, erodes easily.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Ro----------------- Ross	Seepage--------	Piping, hard to pack.	Deep to water	Not needed-----	Not needed-----	Favorable.
Sh----------------- Shoals	Seepage--------	Piping---------	Slow refill----	Floods---------	Not needed-----	Wetness.
St----------------- Sleeth	Seepage--------	Wetness--------	Deep to water, slow refill.	Frost action---	Not needed-----	Wetness.
Sx----------------- Sloan	Seepage--------	Wetness--------	Slow refill----	Floods, poor outlets.	Not needed-----	Wetness.
We----------------- Westland	Seepage--------	Wetness--------	Slow refill----	Percs slowly, floods, frost action.	Not needed-----	Wetness, percs slowly.
Wh----------------- Whitaker	Seepage--------	Wetness--------	Deep to water, slow refill.	Frost action---	Not needed-----	Wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Br: Brookston	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
CrA: Crosby	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
FnA: Fox	Slight	Slight	Slight	Slight.
FnB2: Fox	Slight	Slight	Moderate: slope.	Slight.
FxC3: Fox	Moderate: too clayey, slope.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
Ge: Genesee	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
HeF: Hennepin	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ho: Houghton	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
MmA: Miami	Slight	Slight	Slight	Slight.
MmB2: Miami	Slight	Slight	Moderate: slope.	Slight.
MmC2: Miami	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
MmD2: Miami	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
MoC3: Miami	Moderate: too clayey, slope.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
MoD3: Miami	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey, slope.
MxA: Milton Variant	Slight	Slight	Slight	Slight.
NnA: Nineveh	Slight	Slight	Slight	Slight.
OcA: Ockley	Slight	Slight	Slight	Slight.
OcB2: Ockley	Slight	Slight	Moderate: slope.	Slight.
Or*. Orthents				

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Pa-------------------- Palms	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.
Pn-------------------- Patton	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Ps-------------------- Patton	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Pt*. Pits				
Ra-------------------- Randolph Variant	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Ro-------------------- Ross	Severe: floods.	Slight---------------	Moderate: floods.	Slight.
Sh-------------------- Shoals	Severe: floods, wetness.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, floods.
St-------------------- Sleeth	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Sx-------------------- Sloan	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
We-------------------- Westland	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: wetness.
Wh-------------------- Whitaker	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Br: Brookston	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good
CrA: Crosby	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
FnA, FnB2: Fox	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
FxC3: Fox	Fair	Good	Good	Good	Good	Very poor	Very poor	Fair	Good	Very poor
Ge: Genesee	Poor	Fair	Fair	Good	Good	Poor	Poor	Fair	Good	Poor
HeF: Hennepin	Very poor	Poor	Good	Good	Fair	Very poor	Very poor	Poor	Good	Very poor
Ho: Houghton	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good
MmA, MmB2: Miami	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
MmC2: Miami	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
MmD2: Miami	Poor	Fair	Good	Good	Good	Very poor	Very poor	Fair	Good	Very poor
MoC3: Miami	Fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor
MoD3: Miami	Poor	Fair	Good	Good	Good	Very poor	Very poor	Fair	Good	Very poor
MxA: Milton Variant	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
NnA: Nineveh	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
OcA, OcB2: Ockley	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
Or*. Orthents										
Pa: Palms	Good	Poor	Poor	Poor	Poor	Poor	Poor	Fair	Poor	Poor
Pn: Patton	Good	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good
Ps: Patton	Good	Fair	Fair	Fair	Fair	Good	Good	Poor	Poor	Good
Pt*. Pits										
Ra: Randolph Variant	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Ro: Ross	Good	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor
Sh: Shoals	Poor	Fair	Fair	Good	Good	Fair	Fair	Fair	Good	Fair
St: Sleeth	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
Sx: Sloan	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good
We: Westland	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good
Wh: Whitaker	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Br------------------ Brookston	0-11	Silty clay loam	CL	A-6, A-7	0	100	98-100	95-100	75-95	36-50	15-25
	11-49	Clay loam, silty clay loam.	CL, CH	A-6, A-7	0	98-100	85-100	75-95	60-85	36-52	18-30
	49-60	Loam, sandy loam, clay loam.	CL	A-4, A-6	0-3	90-100	85-95	78-90	55-70	22-30	7-15
CrA----------------- Crosby	0-11	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	80-100	50-90	22-34	6-15
	11-32	Clay loam, silty clay loam.	CL, CH	A-6, A-7	0-3	92-99	89-97	78-93	64-76	37-55	17-31
	32-60	Loam, clay loam, sandy loam.	CL, ML, CL-ML	A-4, A-6	0-3	88-94	83-89	74-87	50-64	17-30	2-14
FnA, FnB2---------- Fox	0-10	Loam-------------	ML	A-4	0	95-100	85-100	75-95	55-90	20-30	2-4
	10-16	Silty clay loam, clay loam.	CL	A-6, A-7	0	85-100	75-100	70-95	55-90	25-45	10-25
	16-36	Gravelly clay loam to gravelly sandy clay loam.	CL, SC	A-6, A-2-6, A-7	0	85-100	75-95	50-95	20-65	25-45	10-25
	36-60	Sand and gravel	SP, SM, GP, GM	A-1, A-2, A-3	0-5	40-100	35-100	15-95	2-15	---	NP
FxC3---------------- Fox	0-7	Clay loam--------	CL	A-6	0	90-100	75-100	75-95	60-80	20-40	10-20
	7-28	Gravelly clay loam to sandy clay loam.	CL, SC	A-6, A-2-6, A-7	0	85-100	75-95	50-95	20-65	25-45	10-25
	28-60	Sand and gravel	SP, SM, GP, GM	A-1, A-2, A-3	0-5	40-100	35-100	15-95	2-15	---	NP
Ge------------------ Genesee	0-7	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	75-85	26-40	3-15
	7-38	Silt loam, loam	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	75-85	26-40	3-15
	38-60	Stratified sandy loam to silt loam.	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	60-80	50-70	26-40	3-15
HeF----------------- Hennepin	0-4	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	70-100	60-95	25-40	5-20
	4-11	Loam, sandy loam, silt loam.	SC, SM-SC, CL, CL-ML	A-4, A-6, A-7	0-5	85-100	80-100	65-100	35-95	20-50	5-25
	11-60	Loam, sandy loam, clay loam.	SC, SM-SC, CL, CL-ML	A-4, A-6, A-7	0-5	85-100	80-100	65-100	35-95	20-50	5-25
Ho------------------ Houghton	0-60	Sapric material	Pt	---	0	---	---	---	---	---	---
MmA, MmB2, MmC2, MmD2-------------- Miami	0-7	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	80-100	50-90	22-34	6-15
	7-30	Clay loam, silty clay loam, sandy clay loam.	CL	A-6, A-7	0	92-99	89-97	78-95	64-95	35-50	17-31
	30-60	Loam, clay loam, sandy loam.	CL, CL-ML, ML	A-4, A-6	0-3	88-94	83-89	74-87	50-64	17-30	2-14

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MoC3, MoD3 Miami	0-5	Clay loam	CL	A-6, A-7	0	100	90-100	75-95	65-95	30-45	15-25
	5-19	Clay loam, silty clay loam, sandy clay loam.	CL	A-6, A-7	0	92-99	89-97	78-95	64-95	35-50	17-31
	19-60	Loam, clay loam, sandy loam.	CL, CL-ML, ML	A-4, A-6	0-3	88-94	83-89	74-87	50-64	17-30	2-14
MxA Milton Variant	0-11	Silt loam	ML, CL-ML	A-4	0-5	95-100	90-100	85-95	80-90	26-36	4-10
	11-26	Silty clay loam, clay loam, silt loam.	CL	A-6, A-7	0-10	85-95	80-95	75-95	65-90	30-45	15-25
	26-41	Clay, flaggy clay loam, flaggy clay.	CL, CH	A-7	5-20	75-95	70-95	65-95	55-90	45-60	28-40
	41	Weathered bedrock.	---	---	---	---	---	---	---	---	---
NnA Nineveh	0-12	Loam	CL	A-6	0	95-100	85-100	75-95	50-75	25-35	10-15
	12-20	Clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	85-100	65-80	35-45	15-25
	20-32	Gravelly clay loam.	SC, CL, GC	A-6, A-7	0-5	65-75	60-75	50-60	40-60	30-45	15-25
	32-60	Stratified sand to very gravelly sand.	SP, GP, SP-SM, GP-GM	A-1	0-5	30-70	20-55	5-20	0-10	---	NP
OcA, OcB2 Ockley	0-17	Silt loam, loam	CL, ML, CL-ML	A-4, A-6	0	100	95-100	80-100	60-90	22-33	3-12
	17-28	Silty clay loam, clay loam.	CL	A-6, A-4	0	100	75-100	65-90	50-90	20-35	8-17
	28-56	Clay loam, gravelly sandy clay loam, loam.	CL, SC, GC	A-6, A-7	0-2	70-85	60-90	50-75	35-60	30-45	11-25
	56-70	Stratified sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1	1-5	30-70	20-55	5-20	2-10	---	NP
Or*. Orthents											
Pa Palms	0-29	Sapric material	Pt	---	---	---	---	---	---	---	---
	29-60	Clay loam, loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
Pn Patton	0-12	Silty clay loam	CL	A-6	0	100	100	95-100	75-95	30-40	10-20
	12-38	Silty clay loam	CL, CH, ML, MH	A-7	0	100	100	95-100	80-100	40-55	15-25
	38-60	Stratified silt loam to silty clay loam.	CL	A-6	0	100	100	95-100	75-95	25-40	10-20
Ps Patton	0-13	Silty clay loam	CL, CH	A-6, A-7	0	100	100	90-100	80-95	35-55	20-35
	13-37	Silty clay loam	CL, CH	A-6, A-7	0	100	100	90-100	80-95	35-55	20-35
	37-52	Stratified silty clay loam to sandy loam.	CL	A-6, A-7	0	100	95-100	90-100	65-95	25-45	10-25
	52	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Pt*. Pits											

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ra----------------- Randolph Variant	0-12	Silt loam-------	ML, CL-ML	A-4, A-6	0-5	90-95	85-95	75-95	50-85	20-35	5-15
	12-38	Clay loam, silty clay loam, gravelly clay loam.	CL, CH	A-6, A-7	0-10	75-95	70-90	65-90	55-85	35-55	15-30
	38-41	Silty clay, silty clay loam, gravelly silty clay loam.	CL, CH	A-6, A-7	0-10	75-95	70-90	65-90	50-85	35-60	15-40
	41-44	Weathered bedrock.	---	---	---	---	---	---	---	---	---
	44	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ro----------------- Ross	0-34	Loam, silt loam	ML	A-4	0	90-100	85-100	80-100	65-90	20-40	NP-10
	34-60	Loam, sandy clay loam.	ML	A-4, A-6	0	80-100	75-100	70-100	65-90	20-40	NP-12
Sh----------------- Shoals	0-11	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	90-100	65-90	22-36	6-15
	11-39	Silt loam, loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	75-85	25-40	4-15
	39-56	Sandy loam, sandy clay loam.	ML	A-4, A-2	0-3	90-100	85-100	60-80	35-60	32-40	3-8
	56-60	Coarse sand and gravelly sand.	SP, SP-SM	A-1, A-3	1-5	55-90	50-90	20-60	3-10	---	NP
St----------------- Sleeth	0-15	Loam------------	CL, ML, CL-ML	A-4, A-6	0	100	90-100	75-95	50-85	26-30	3-12
	15-20	Clay loam, silty clay loam.	CL	A-6	0	85-95	85-95	80-90	65-75	30-40	15-25
	20-47	Sandy clay loam, gravelly sandy clay.	CL	A-6	0-3	80-95	80-90	60-80	35-50	30-40	15-25
	47-60	Stratified sand to gravelly sand.	SP, SP-SM	A-1, A-3	1-5	50-80	45-75	25-55	2-10	---	NP
Sx----------------- Sloan	0-8	Silty clay loam	CL	A-6, A-7	0	90-100	85-95	80-95	60-90	35-50	15-30
	8-34	Loam, silty clay loam, clay loam.	CL	A-6, A-7	0	85-95	80-95	65-95	50-85	30-50	10-30
	34-40	Stratified sandy loam to silty clay loam.	CL-ML, CL, ML	A-4, A-5, A-6, A-7	0	85-95	80-95	45-95	35-85	25-45	5-20
	40-60	Coarse sand, gravelly sand.	SP, SP-SM	A-1, A-3	0-5	55-90	50-90	20-60	3-10	---	NP
We----------------- Westland	0-16	Silty clay loam	CL, ML	A-6, A-7	0	100	95-100	90-100	75-90	30-45	10-25
	16-42	Clay loam-------	CL	A-6, A-7	0	95-100	90-100	80-90	65-75	35-50	15-30
	42-46	Gravelly clay loam, gravelly sandy loam.	CL	A-6	0-5	65-75	60-70	55-70	50-70	30-50	15-30
	46-60	Stratified sand to gravelly sand.	SP, GP, SP-SM, GP-GM	A-1	1-5	30-70	22-55	7-20	2-10	---	NP
Wh----------------- Whitaker	0-13	Loam------------	CL, CL-ML	A-4, A-6	0	100	95-100	80-100	60-90	22-33	4-12
	13-38	Clay loam, loam, sandy clay loam.	CL	A-6, A-7	0	100	95-100	90-100	70-80	30-47	12-26
	38-60	Stratified coarse sand to clay.	CL, SC, ML, SM	A-4	0	98-100	98-100	60-85	40-60	15-25	3-9

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH						
Br------------------ Brookston	0-11	0.6-2.0	0.21-0.24	6.6-7.3	Moderate	High------	Low-------	0.28	5	7
	11-49	0.6-2.0	0.15-0.19	6.6-7.3	Moderate	High------	Low-------	0.28		
	49-60	0.6-2.0	0.05-0.19	7.4-8.4	Moderate	High------	Low-------	0.28		
CrA----------------- Crosby	0-11	0.6-2.0	0.20-0.24	5.1-6.5	Low-------	High------	Moderate	0.43	3-2	5
	11-32	0.06-0.2	0.15-0.20	5.1-7.3	Moderate	High------	Moderate	0.43		
	32-60	0.06-0.6	0.05-0.19	7.9-8.4	Low-------	High------	Low-------	0.43		
FnA, FnB2---------- Fox	0-10	0.6-2.0	0.20-0.22	5.1-6.5	Low-------	Low-------	Moderate	0.32	3-2	6
	10-16	0.6-2.0	0.18-0.20	5.1-6.0	Moderate	Low-------	Moderate	0.32		
	16-36	0.6-2.0	0.12-0.14	6.1-7.8	Moderate	Low-------	Moderate	0.32		
	36-60	>6.0	0.02-0.04	7.9-8.4	Low-------	Low-------	Low-------	0.10		
FxC3---------------- Fox	0-7	0.6-2.0	0.17-0.19	5.1-6.5	Moderate	Low-------	Moderate	0.32	3-2	6
	7-28	0.6-2.0	0.12-0.14	6.1-7.8	Moderate	Low-------	Moderate	0.32		
	28-60	>6.0	0.02-0.04	7.9-8.4	Low-------	Low-------	Low-------	0.10		
Ge------------------ Genesee	0-7	0.6-2.0	0.20-0.24	6.1-7.8	Low-------	Low-------	Low-------	0.37	5	5
	7-38	0.6-2.0	0.17-0.22	6.1-8.4	Low-------	Low-------	Low-------	0.37		
	38-60	0.6-2.0	0.19-0.21	7.4-8.4	Low-------	Low-------	Low-------	0.37		
HeF----------------- Hennepin	0-4	0.6-2.0	0.18-0.24	6.1-7.8	Low-------	Low-------	Low-------	0.32	4-3	5
	4-11	0.2-2.0	0.14-0.22	6.1-7.8	Low-------	Low-------	Low-------	0.32		
	11-60	0.2-0.6	0.07-0.11	6.1-8.4	Low-------	Low-------	Low-------	0.32		
Ho------------------ Houghton	0-60	2.0-6.0	0.35-0.45	6.6-7.3	----------	High------	Low-------	0.10	5	3
MmA, MmB2, MmC2, MmD2--------------- Miami	0-7	0.6-2.0	0.20-0.24	5.6-7.3	Low-------	Low-------	Moderate	0.37	5	5
	7-30	0.6-2.0	0.15-0.20	5.6-6.0	Moderate	Moderate	Moderate	0.37		
	30-60	0.2-2.0	0.05-0.19	6.6-8.4	Low-------	Low-------	Low-------	0.37		
MoC3, MoD3---------- Miami	0-5	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	Moderate	Moderate	0.37	4	6
	5-19	0.6-2.0	0.15-0.20	5.6-6.0	Moderate	Moderate	Moderate	0.37		
	19-60	0.2-0.6	0.05-0.19	6.6-8.4	Low-------	Low-------	Low-------	0.37		
MxA----------------- Milton Variant	0-11	0.6-2.0	0.22-0.24	5.6-7.3	Low-------	Moderate	Moderate	0.37	4	6
	11-26	0.6-2.0	0.12-0.20	5.1-7.3	Moderate	Moderate	Moderate	0.37		
	26-41	0.6-2.0	0.06-0.15	5.1-7.3	Moderate	High------	Low-------	0.28		
	41	---	---	---	----------	----------	----------	---		
NnA----------------- Nineveh	0-12	0.6-2.0	0.20-0.22	6.6-7.3	Low-------	Low-------	Low-------	0.28	4-3	5
	12-20	0.6-2.0	0.15-0.19	6.6-7.3	Moderate	Low-------	Low-------	0.28		
	20-32	0.6-2.0	0.13-0.16	6.6-7.8	Moderate	Low-------	Low-------	0.20		
	32-60	>20	0.02-0.04	7.4-8.4	Low-------	Low-------	Low-------	0.10		
OcA, OcB2----------- Ockley	0-17	0.6-2.0	0.20-0.24	5.6-6.5	Low-------	Low-------	Moderate	0.37	5	5
	17-28	0.6-2.0	0.15-0.20	4.5-6.0	Moderate	Moderate	Moderate	0.37		
	28-56	0.6-2.0	0.12-0.14	5.6-6.5	Moderate	Moderate	Moderate	0.24		
	56-70	>20	0.02-0.04	7.4-8.4	Low-------	Low-------	Low-------	0.10		
Or*. Orthents										
Pa------------------ Palms	0-29	2.0-6.0	0.35-0.45	5.1-8.4	----------	High------	Moderate	0.10	5	3
	29-60	0.2-2.0	0.14-0.22	6.1-8.4	Low-------	High------	Low-------	0.10		
Pn------------------ Patton	0-12	0.6-2.0	0.21-0.23	6.6-7.3	Moderate	High------	Low-------	0.28	5	7
	12-38	0.6-2.0	0.18-0.20	6.1-7.8	Moderate	High------	Low-------	0.28		
	38-60	0.6-2.0	0.18-0.22	7.4-7.8	Moderate	High------	Low-------	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea-bility	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodi-bility group
	In	In/hr	In/in	pH						
Ps------------------ Patton	0-13	0.6-2.0	0.21-0.23	6.1-7.3	Moderate	High------	Low--------	0.28	5	7
	13-37	0.6-2.0	0.18-0.20	6.1-7.8	Moderate	High------	Low--------	0.28		
	37-52	0.6-2.0	0.17-0.22	7.4-8.4	Moderate	High------	Low--------	0.28		
	52	---	---	---	----------	----------	----------	---		
Pt*. Pits										
Ra------------------ Randolph Variant	0-12	0.6-2.0	0.20-0.24	5.1-7.3	Moderate	High------	Moderate	0.43	3	5
	12-38	0.2-0.6	0.10-0.15	5.1-7.3	Moderate	High------	Moderate	0.43		
	38-41	0.2-0.6	0.10-0.15	6.6-8.4	Moderate	High------	Low--------	0.43		
	41-44	---	---	---	----------	----------	----------	---		
	44	---	---	---	----------	----------	----------	---		
Ro------------------ Ross	0-34	0.6-2.0	0.16-0.22	6.1-7.8	Low--------	Low--------	Low--------	0.32	5	5
	34-60	0.6-2.0	0.16-0.22	6.1-7.8	Low--------	Low--------	Low--------	0.32		
Sh------------------ Shoals	0-11	0.6-2.0	0.22-0.24	6.1-7.8	Low--------	High------	Low--------	0.37	5	5
	11-39	0.6-2.0	0.17-0.22	6.1-7.8	Low--------	High------	Low--------	0.37		
	39-56	0.6-2.0	0.12-0.21	6.6-7.3	Low--------	High------	Low--------	0.37		
	56-60	2.0-6.0	0.02-0.05	6.6-7.8	Low--------	High------	Low--------	---		
St------------------ Sleeth	0-15	0.6-2.0	0.20-0.24	5.6-7.3	Low--------	High------	Low--------	0.32	5	5
	15-20	0.6-2.0	0.15-0.19	5.6-6.5	Moderate	High------	Low--------	0.32		
	20-47	0.6-2.0	0.14-0.16	6.6-8.4	Moderate	High------	Low--------	0.32		
	47-60	>20	0.02-0.04	7.9-8.4	Low--------	Low--------	Low--------	0.10		
Sx------------------ Sloan	0-8	0.6-2.0	0.17-0.20	6.1-7.3	Moderate	High------	Low--------	0.37	5	7
	8-34	0.2-2.0	0.17-0.20	6.1-7.8	Moderate	High------	Low--------	0.37		
	34-40	0.2-2.0	0.19-0.21	6.6-8.4	Low--------	High------	Low--------	0.37		
	40-60	6.0-20	0.02-0.05	6.6-8.4	Low--------	High------	Low--------	0.10		
We------------------ Westland	0-16	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	High------	Low--------	0.28	5	7
	16-42	0.06-0.2	0.15-0.19	5.6-7.3	Moderate	High------	Low--------	0.28		
	42-46	0.06-0.2	0.14-0.16	5.6-7.3	Moderate	High------	Low--------	0.28		
	46-60	>20	0.02-0.04	7.4-8.4	Low--------	High------	Low--------	0.10		
Wh------------------ Whitaker	0-13	0.6-2.0	0.20-0.24	5.6-7.3	Low--------	Moderate	Moderate	0.37	5	5
	13-38	0.6-2.0	0.15-0.19	5.1-6.0	Moderate	High------	Moderate	0.37		
	38-60	0.6-6.0	0.19-0.21	6.6-8.4	Low--------	High------	Low--------	0.37		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	
					Ft			In		
Br----------------- Brookston	B/D	Frequent----	Brief-----	Dec-May	0-1.0	Apparent	Dec-May	>60	---	High.
CrA---------------- Crosby	C	None---------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	High.
FnA, FnB2, FxC3--- Fox	B	None---------	---	---	>6.0	---	---	>60	---	Moderate.
Ge----------------- Genesee	B	Frequent----	Brief-----	Oct-Jun	>6.0	---	---	>60	---	Moderate.
HeF---------------- Hennepin	B	None---------	---	---	>6.0	---	---	>60	---	Moderate.
Ho----------------- Houghton	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Sep-Jun	>60	---	High.
MmA, MmB2, MmC2, MmD2, MoC3, MoD3- Miami	B	None---------	---	---	>6.0	---	---	>60	---	Moderate.
MxA---------------- Milton Variant	C	None---------	---	---	>6.0	---	---	40-50	Hard	Moderate.
NnA---------------- Nineveh	B	None---------	---	---	>6.0	---	---	>60	---	Moderate.
OcA, OcB2---------- Ockley	B	None---------	---	---	>6.0	---	---	>60	---	Moderate.
Or*. Orthents										
Pa----------------- Palms	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High.
Pn----------------- Patton	B/D	Rare---------	---	---	0-1.0	Apparent	Mar-Jun	>60	---	High.
Ps----------------- Patton	B/D	Rare---------	---	---	0-1.0	Apparent	Jan-May	40-60	---	High.
Pt*. Pits										
Ra----------------- Randolph Variant	D	None---------	---	---	1.0-3.0	Perched	Jan-Apr	40-50	Hard	High.
Ro----------------- Ross	B	Common------	Very brief	Nov-Jun	4.0-6.0	Apparent	Feb-Apr	>60	---	Moderate.
Sh----------------- Shoals	C	Rare to frequent.	Brief-----	Oct-Jun	1.0-3.0	Apparent	Jan-Apr	>60	---	High.
St----------------- Sleeth	C	None---------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	High.
Sx----------------- Sloan	B/D	Frequent----	Very brief	Nov-Jun	0-0.5	Apparent	Nov-Jun	>60	---	High.
We----------------- Westland	B/D	Frequent----	Brief-----	Dec-May	0-1.0	Apparent	Dec-May	>60	---	High.
Wh----------------- Whitaker	C	None---------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	High.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Brookston	Fine-loamy, mixed, mesic Typic Argiaquolls
Crosby	Fine, mixed, mesic Aeric Ochraqualfs
Fox	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs
*Genesee	Fine-loamy, mixed, nonacid, mesic Typic Udifluvents
Hennepin	Fine-loamy, mixed, mesic Typic Eutrochrepts
Houghton	Euic, mesic Typic Medisaprists
Miami	Fine-loamy, mixed, mesic Typic Hapludalfs
Milton Variant	Fine, mixed, mesic Typic Hapludalfs
Nineveh	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiudolls
Ockley	Fine-loamy, mixed, mesic Typic Hapludalfs
Orthents	Loamy, mixed, nonacid, mesic Typic Udorthents
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Patton	Fine-silty, mixed, mesic Typic Haplaquolls
Randolph Variant	Fine-loamy, mixed, mesic Aeric Ochraqualfs
Ross	Fine-loamy, mixed, mesic Cumulic Hapludolls
Shoals	Fine-loamy, mixed, nonacid, mesic Aeric Fluvaquents
Sleeth	Fine-loamy, mixed, mesic Aeric Ochraqualfs
Sloan	Fine-loamy, mixed, mesic Fluvaquentic Haplaquolls
Westland	Fine-loamy, mixed, mesic Typic Argiaquolls
Whitaker	Fine-loamy, mixed, mesic Aeric Ochraqualfs

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Accessibility Statement

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

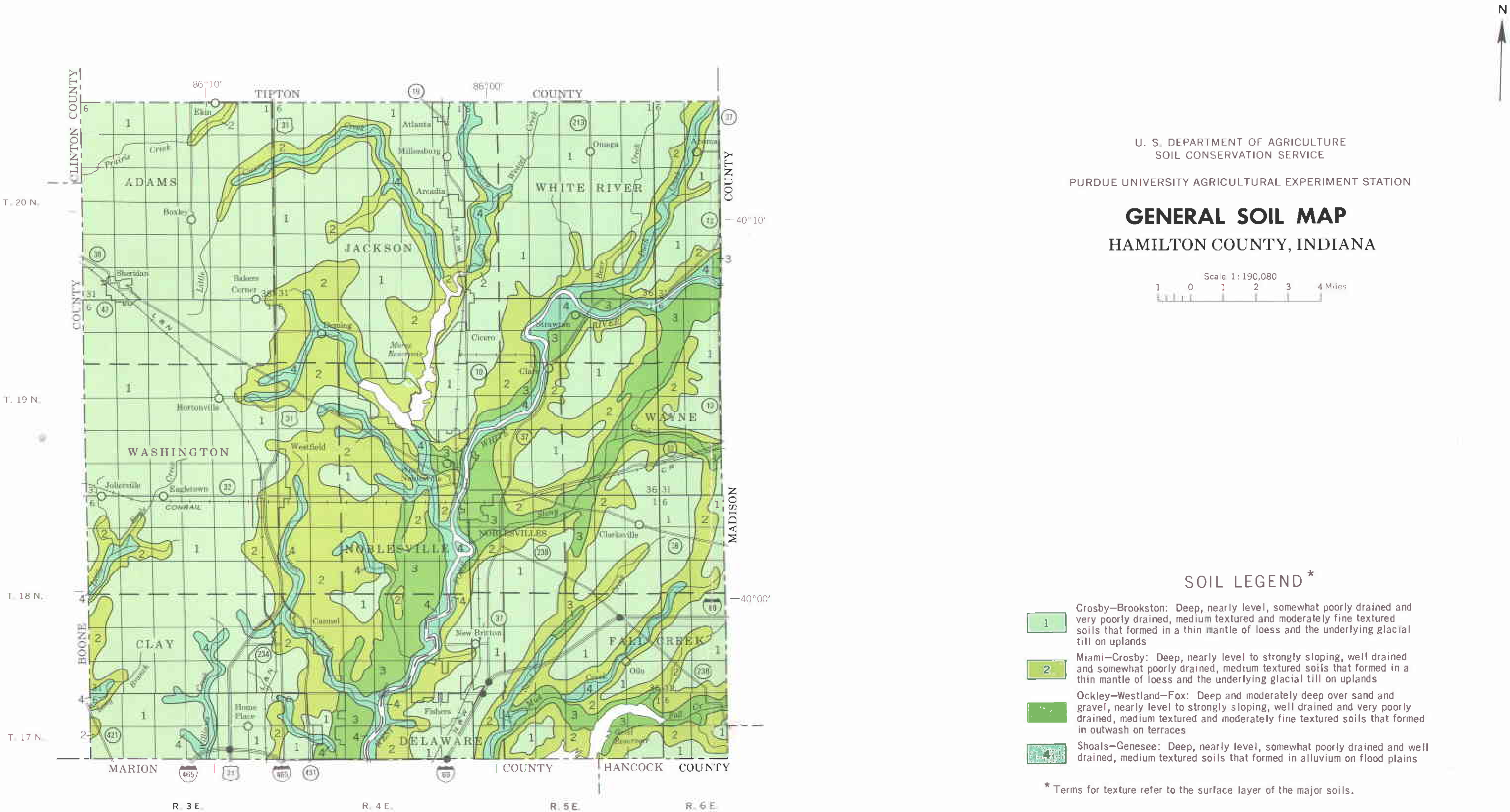
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

HAMILTON COUNTY, INDIANA

Scale 1:190,080

1 0 1 2 3 4 Miles



SOIL LEGEND*

1	Crosby–Brookston: Deep, nearly level, somewhat poorly drained and very poorly drained, medium textured and moderately fine textured soils that formed in a thin mantle of loess and the underlying glacial till on uplands
2	Miami–Crosby: Deep, nearly level to strongly sloping, well drained and somewhat poorly drained, medium textured soils that formed in a thin mantle of loess and the underlying glacial till on uplands
3	Ockley–Westland–Fox: Deep and moderately deep over sand and gravel, nearly level to strongly sloping, well drained and very poorly drained, medium textured and moderately fine textured soils that formed in outwash on terraces
4	Shoals–Genesee: Deep, nearly level, somewhat poorly drained and well drained, medium textured soils that formed in alluvium on flood plains

* Terms for texture refer to the surface layer of the major soils.

Compiled 1977

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

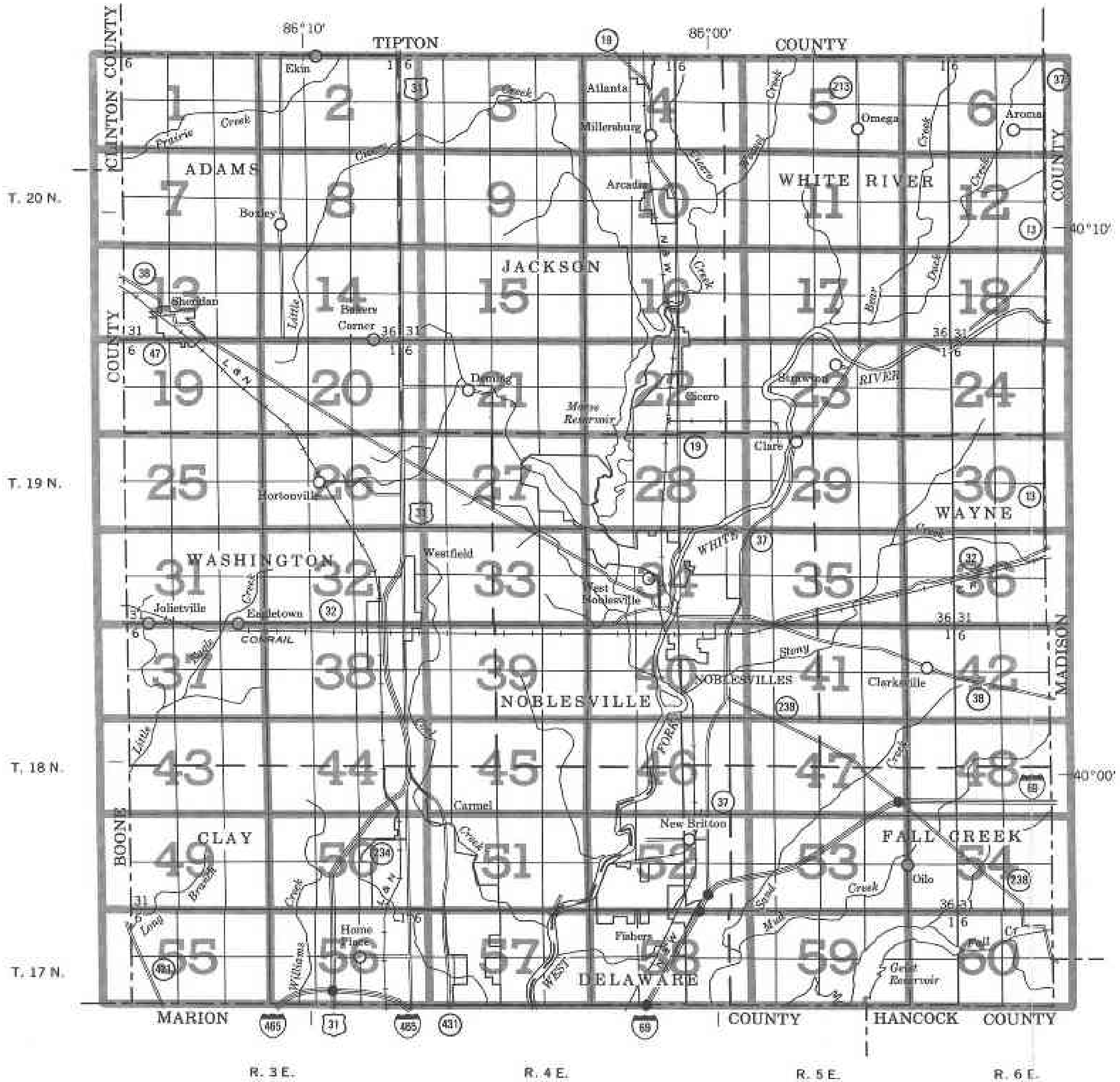
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

HAMILTON COUNTY, INDIANA

Scale 1:190,080



N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

The first capital letter is the initial one of the soil name. The lower case that follows separates mapping units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are those with a slope range of 0 to 2 percent, or they are for miscellaneous areas with considerable range of slope. A final number, 2 or 3, in the symbol indicates that the soil is eroded or severely eroded, respectively.

SYMBOL	NAME
Br	Brookston silty clay loam
CrA	Crosby silt loam, 0 to 3 percent slopes
FnA	Fox loam, 0 to 2 percent slopes
FnB2	Fox loam, 2 to 6 percent slopes, eroded
FxC3	Fox clay loam, 8 to 18 percent slopes, severely eroded
Ge	Genesee silt loam
HeF	Hennepin loam, 18 to 50 percent slopes
Ho	Houghton muck
MmA	Miami silt loam, 0 to 2 percent slopes
MmB2	Miami silt loam, 2 to 6 percent slopes, eroded
MmC2	Miami silt loam, 6 to 12 percent slopes, eroded
MmD2	Miami silt loam, 12 to 18 percent slopes, eroded
MoC3	Miami clay loam, 6 to 12 percent slopes, severely eroded
MoD3	Miami clay loam, 12 to 18 percent slopes, severely eroded
MxA	Milton Variant silt loam, 0 to 2 percent slopes
NnA	Nineveh loam, 0 to 2 percent slopes
OcA	Ockley silt loam, 0 to 2 percent slopes
OcB2	Ockley silt loam, 2 to 6 percent slopes, eroded
Or	Orthents
Pa	Palms muck
Pn	Patton silty clay loam
Ps	Patton silty clay loam, limestone substratum
Pt	Pits
Ra	Randolph Variant silt loam
Ro	Ross loam
Sh	Shoals silt loam
St	Sleeth loam
Sx	Sloan silty clay loam, sandy substratum
We	Westland silty clay loam
Wh	Whitaker loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

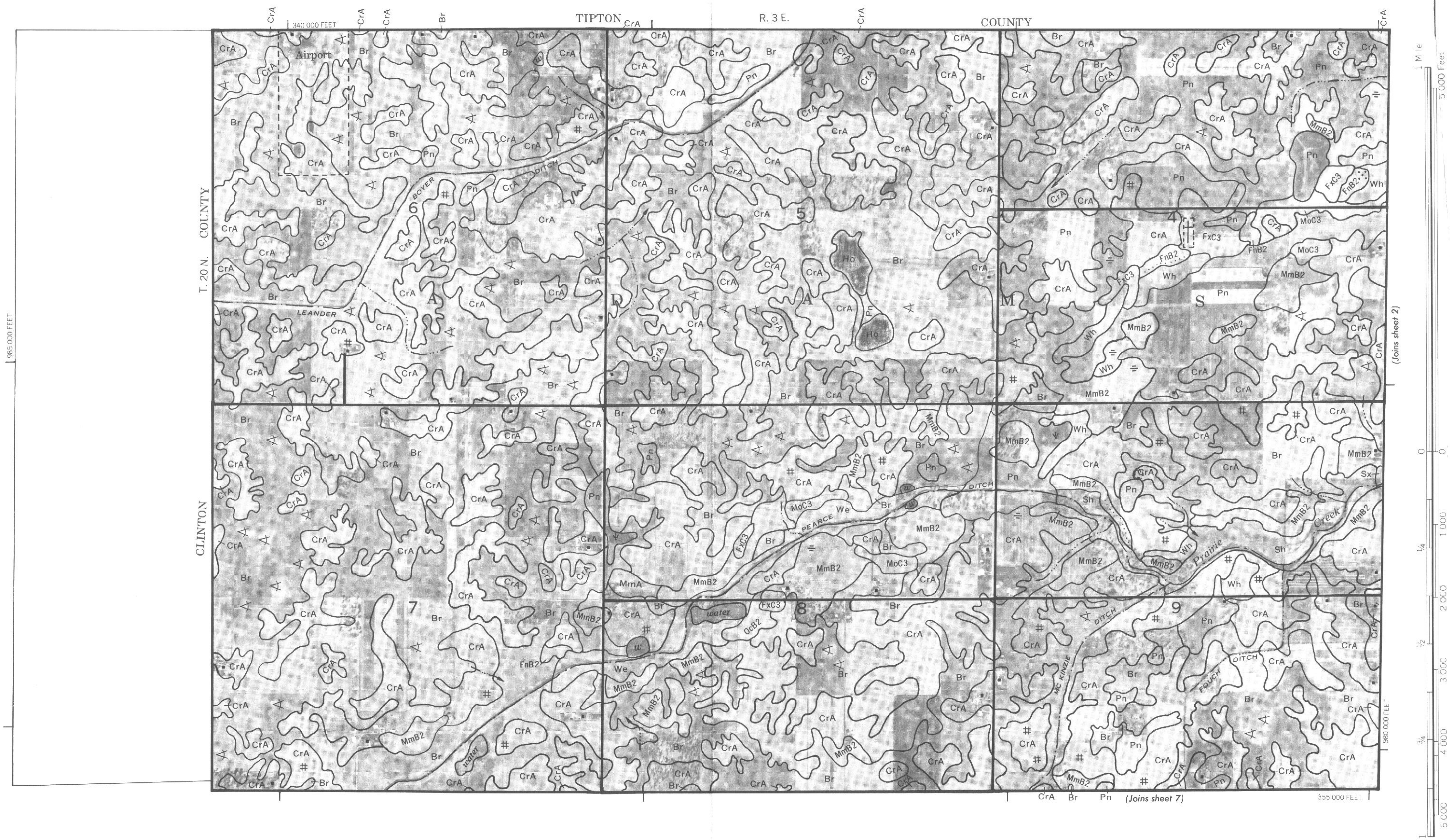
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

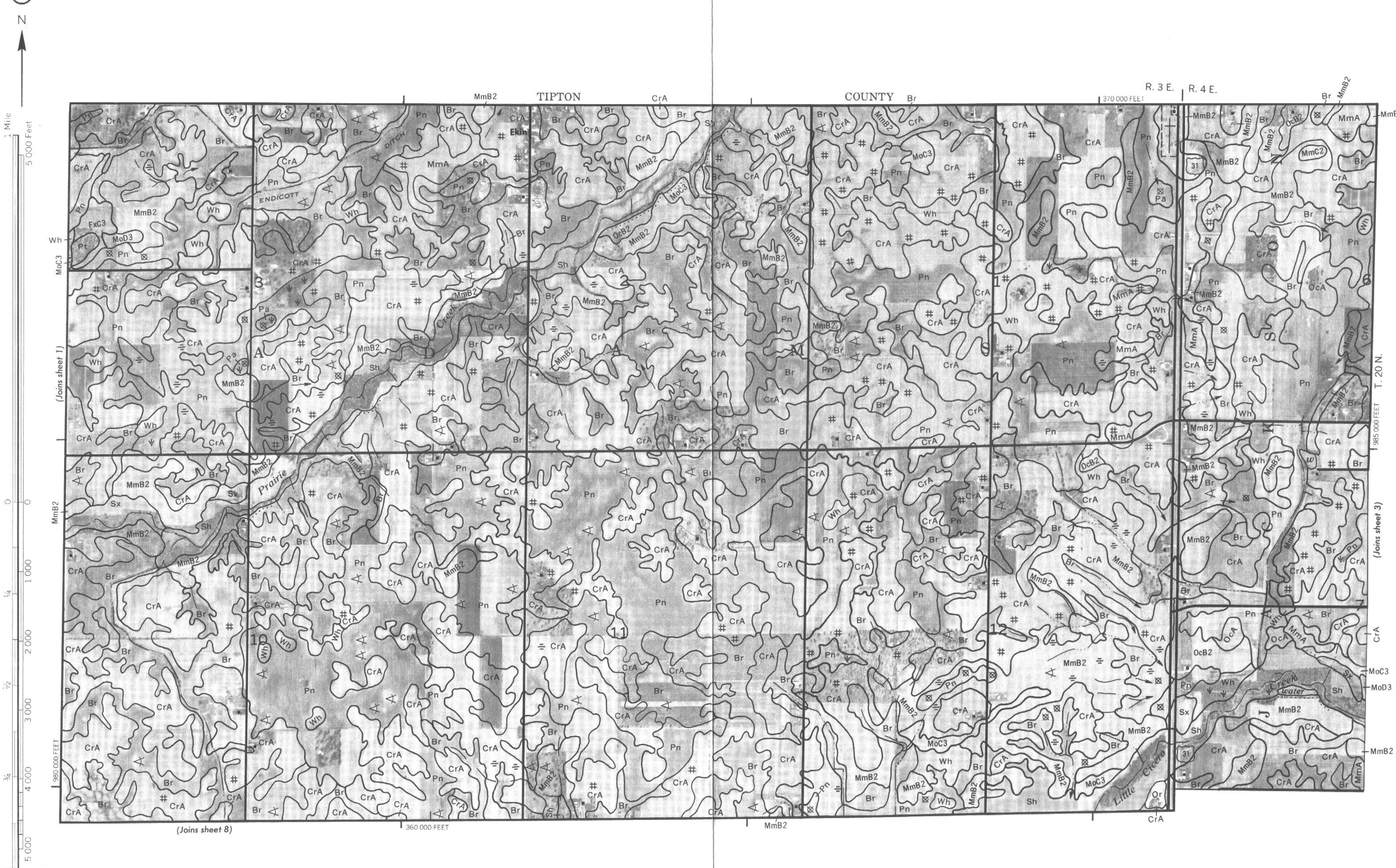
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Overwash (10 to 40 inches)
- Crosby spot < 3 acres
- Miami spot < 3 acres



HAMILTON COUNTY, INDIANA NO. 1

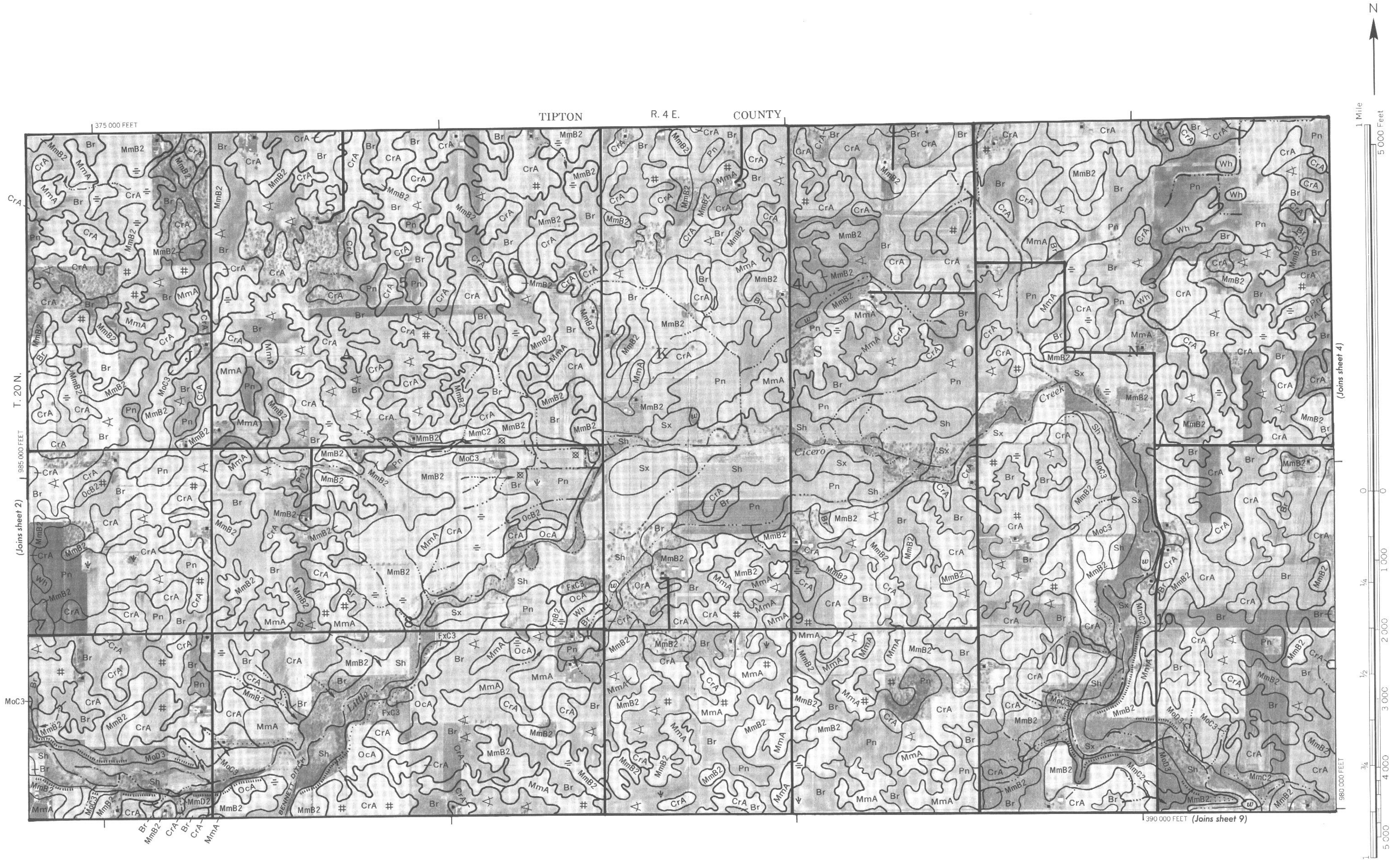
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

2



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

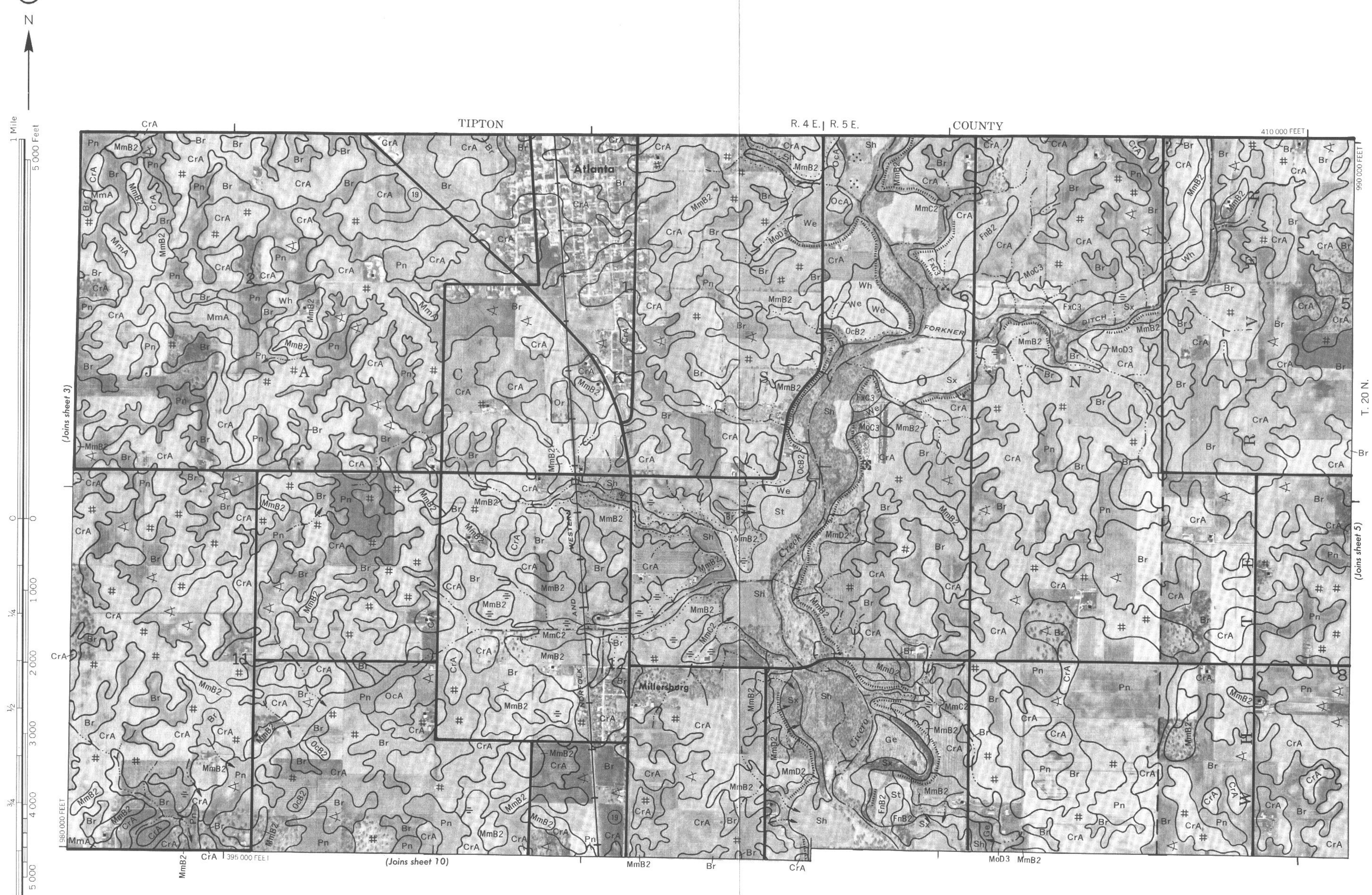
3



HAMILTON COUNTY, INDIANA NO. 3

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA — SHEET NUMBER 4



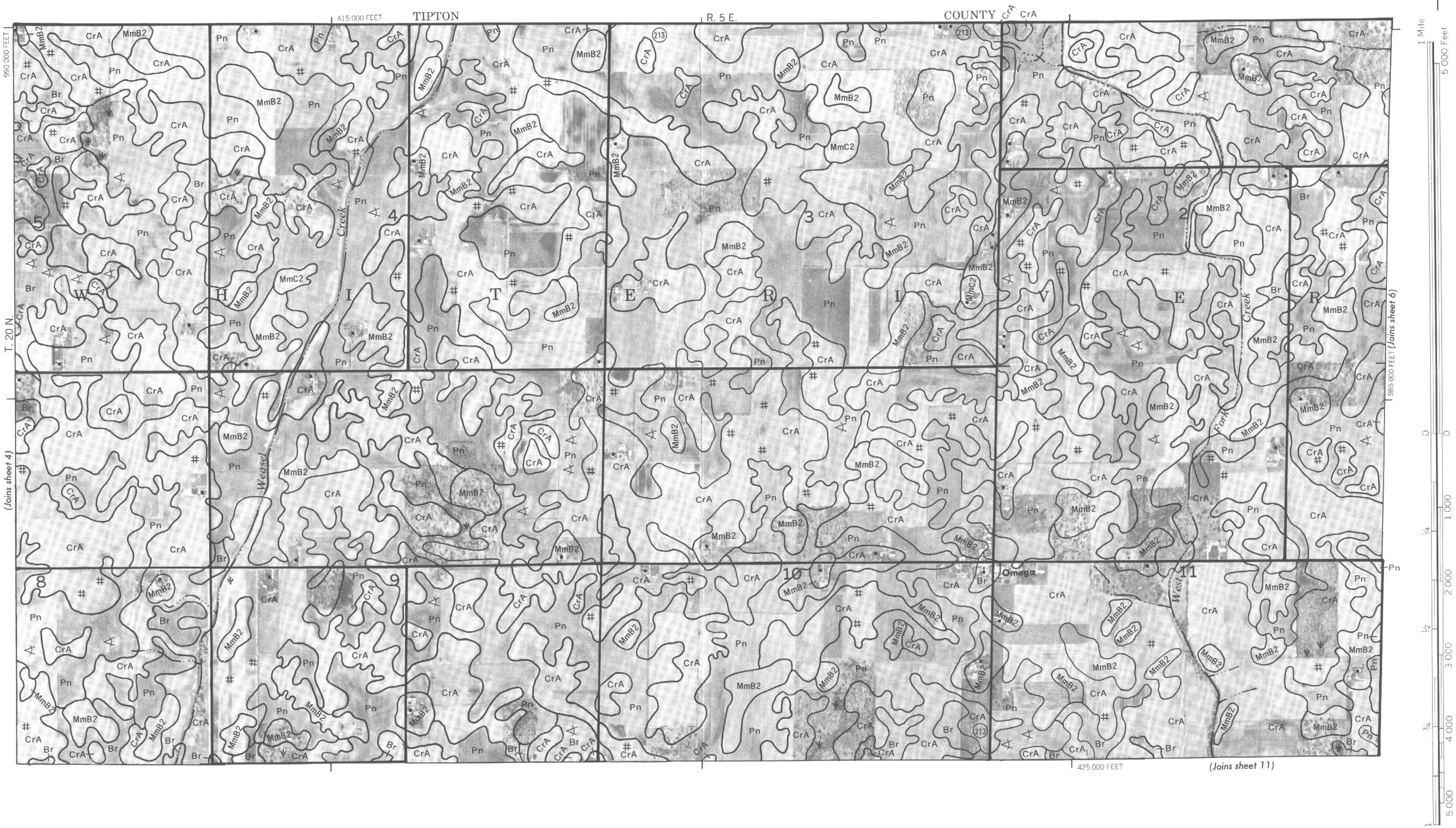
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

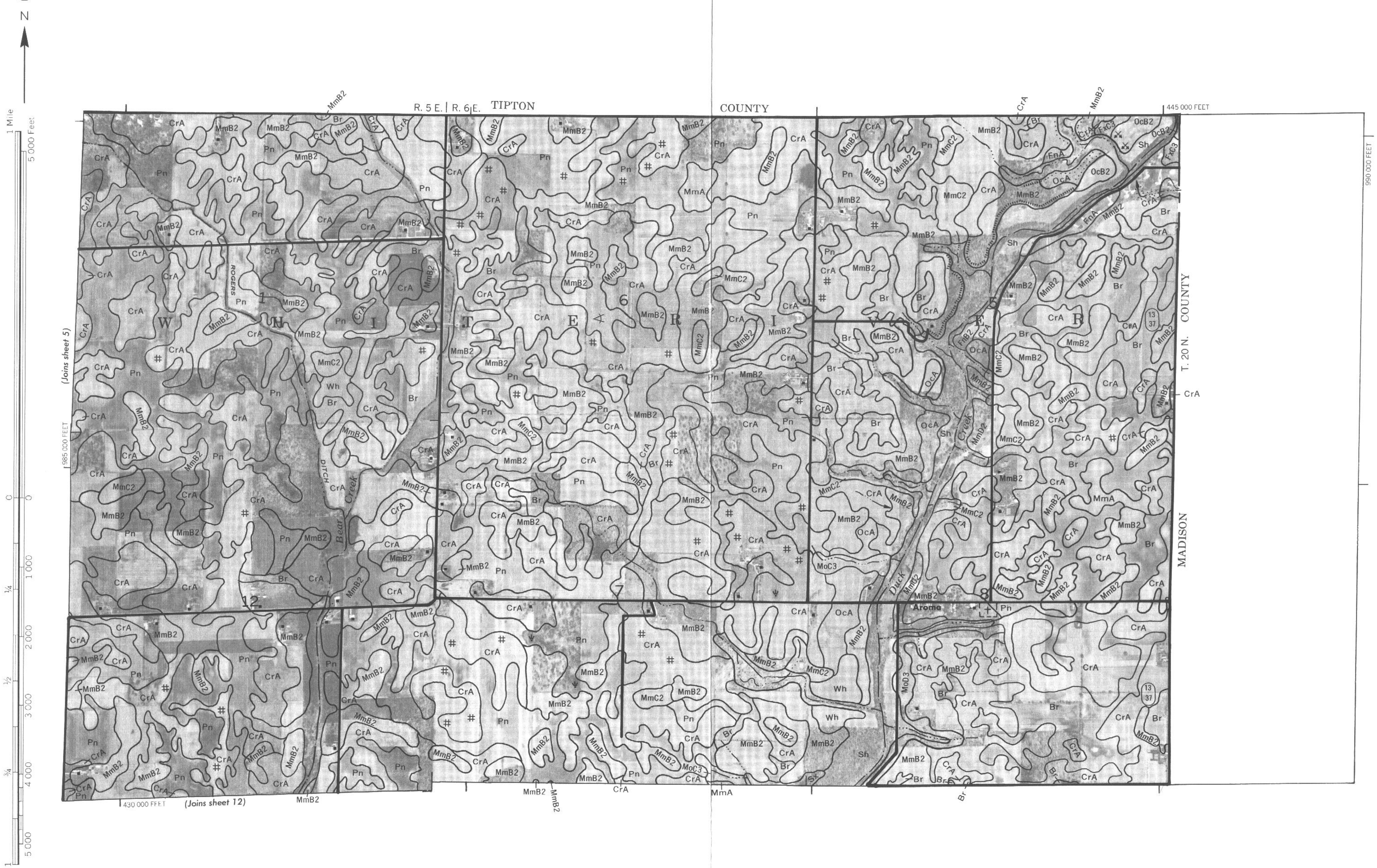
HAMILTON COUNTY, INDIANA NO. 4

5

HAMILTON COUNTY, INDIANA NO. 5

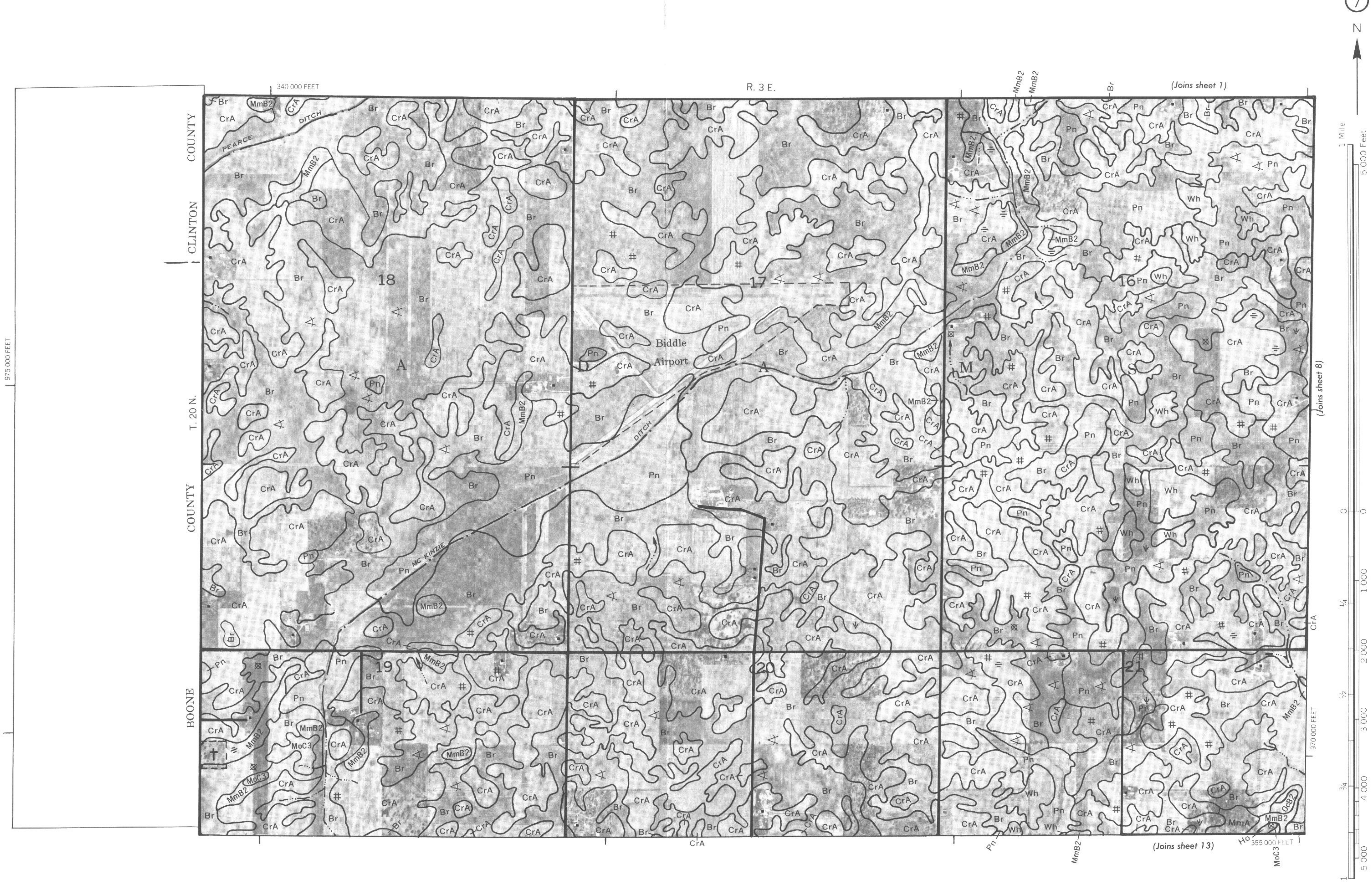
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





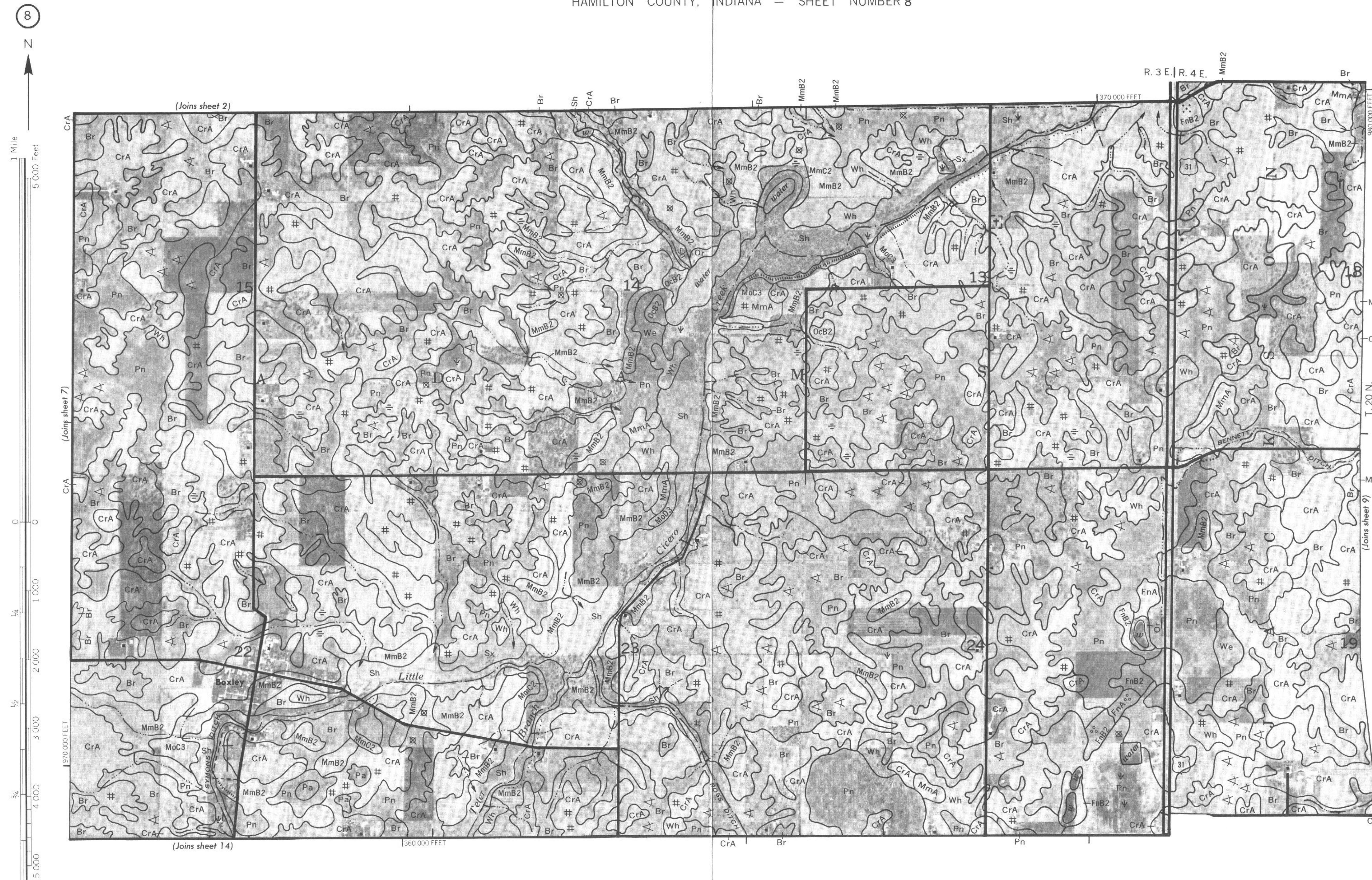
HAMILTON COUNTY, INDIANA NO. 6

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HAMILTON COUNTY, INDIANA NO. 7

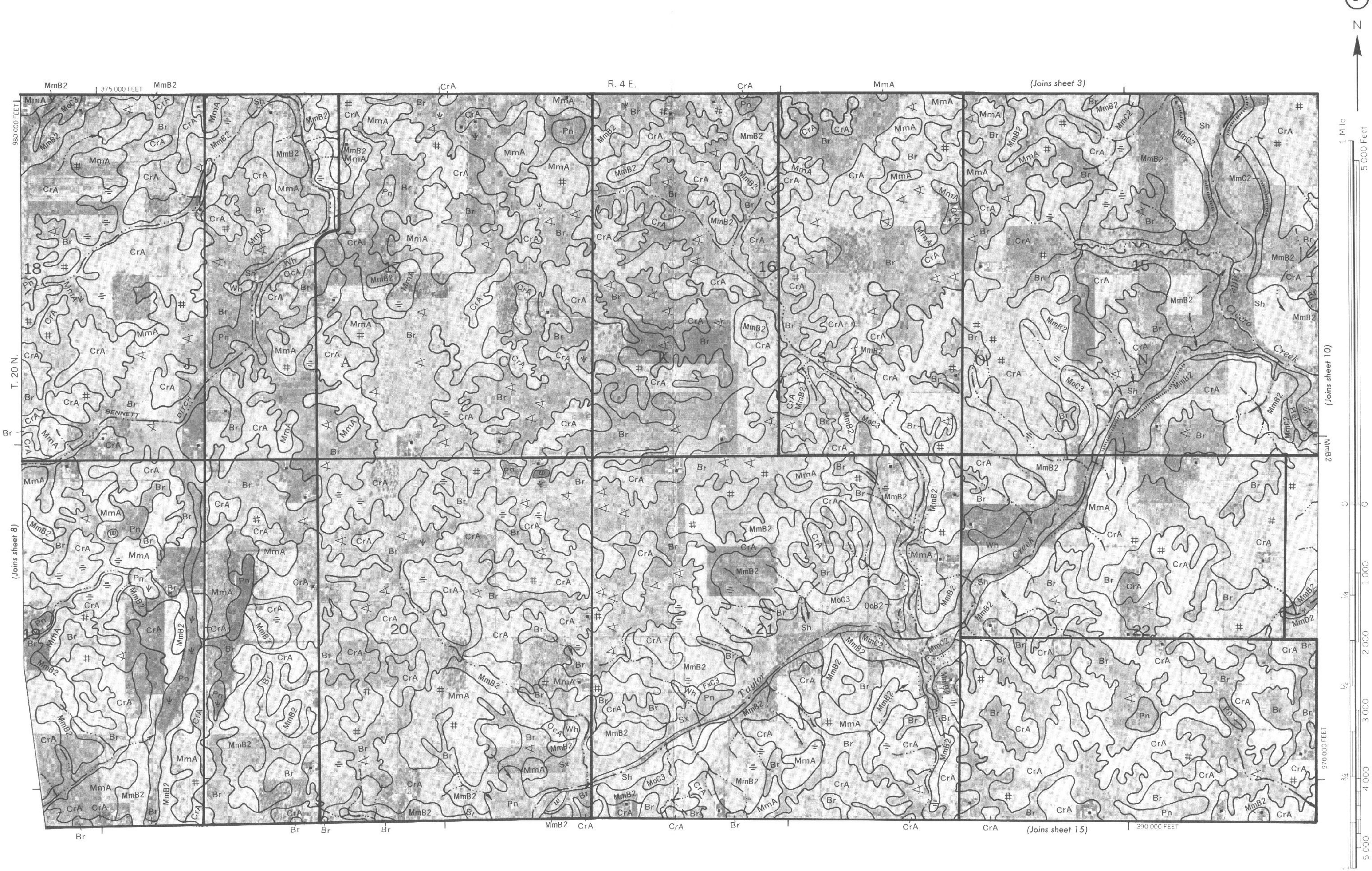
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

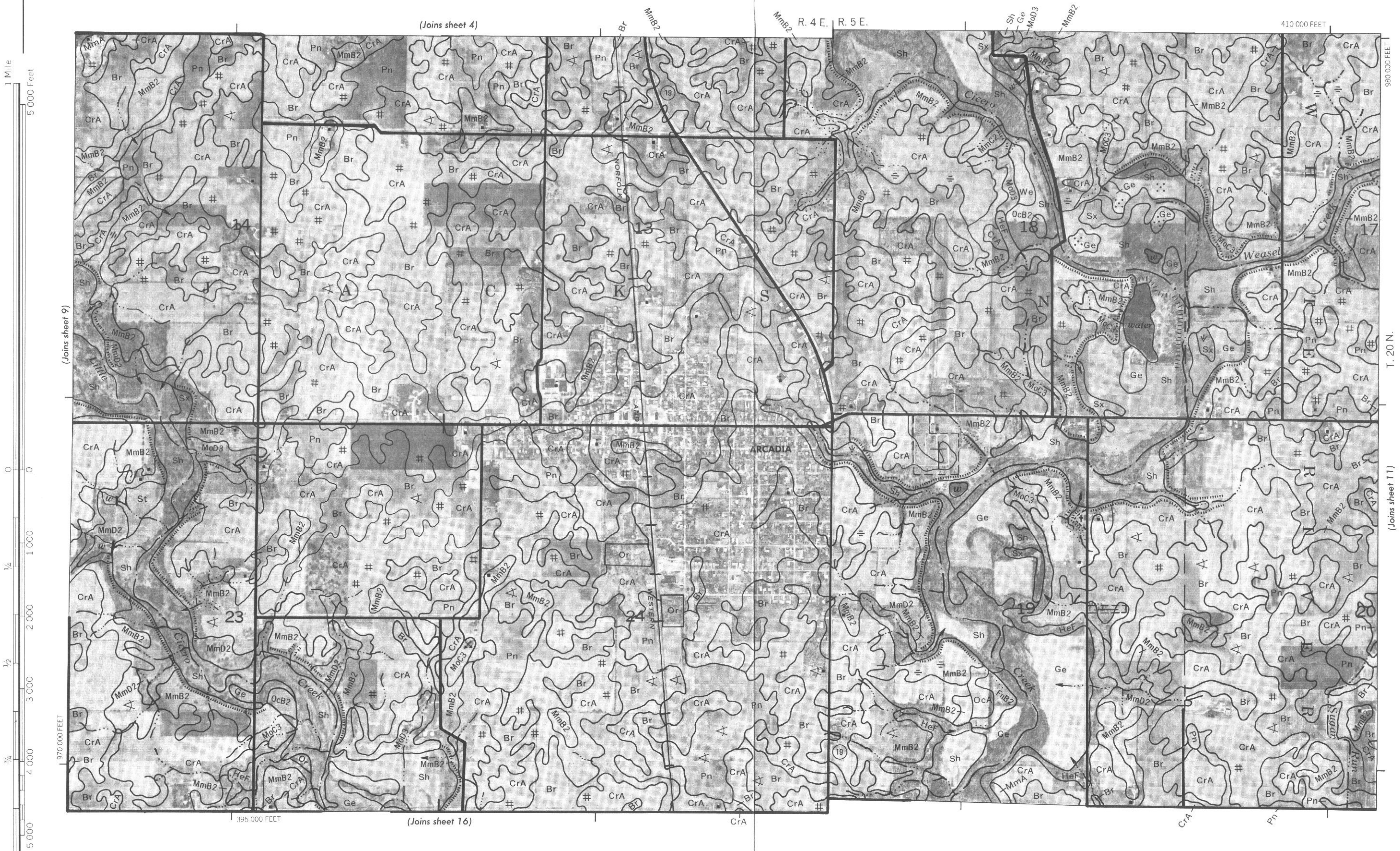


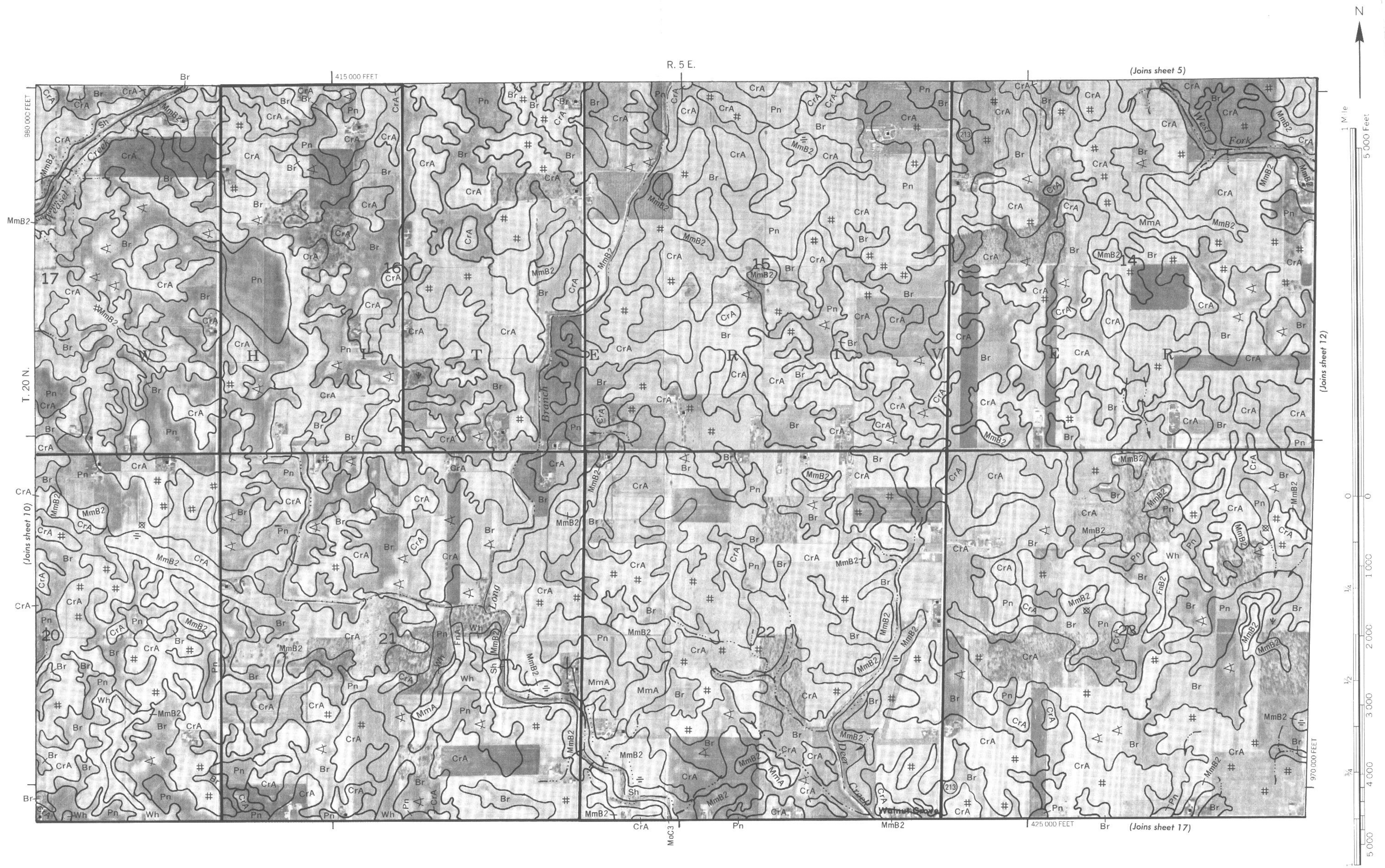
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 8

HAMILTON COUNTY, INDIANA NO. 9




N
1 Mile
5 000 Feet
(Joins sheet 4)
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 16)
R. 4 E.
R. 5 E.
T. 20 N.
410 000 FEET
980 000 FEET
970 000 FEET
395 000 FEET
ARCADIA
JACKSON
NORFOLK AND WESTERN
WHITE RIVER
Cicero
Little Cicero Creek
Weasel Creek
Sugar Run
water
13
14
17
18
19
20
23
24

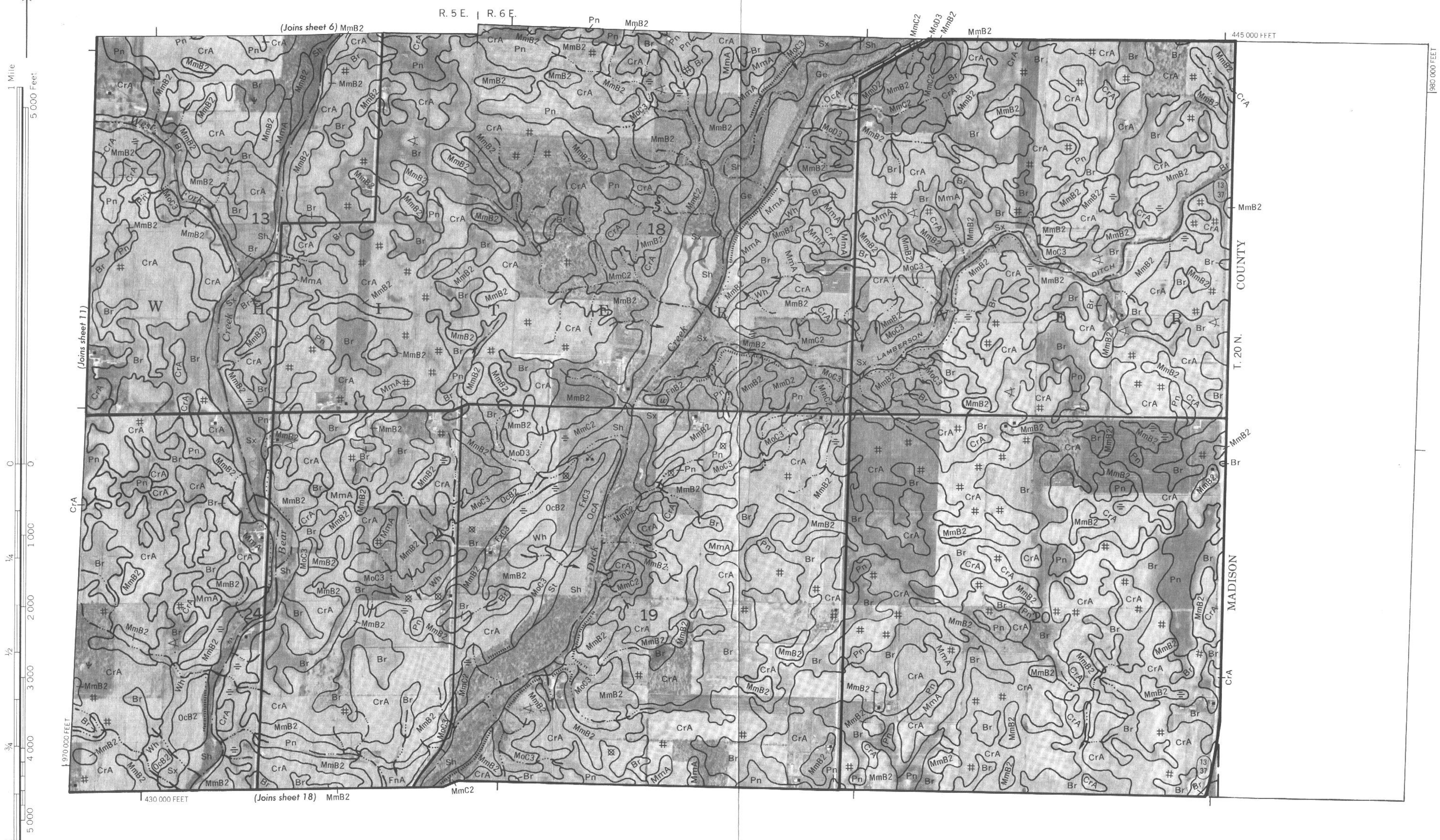


HAMILTON COUNTY, INDIANA NO. 11

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

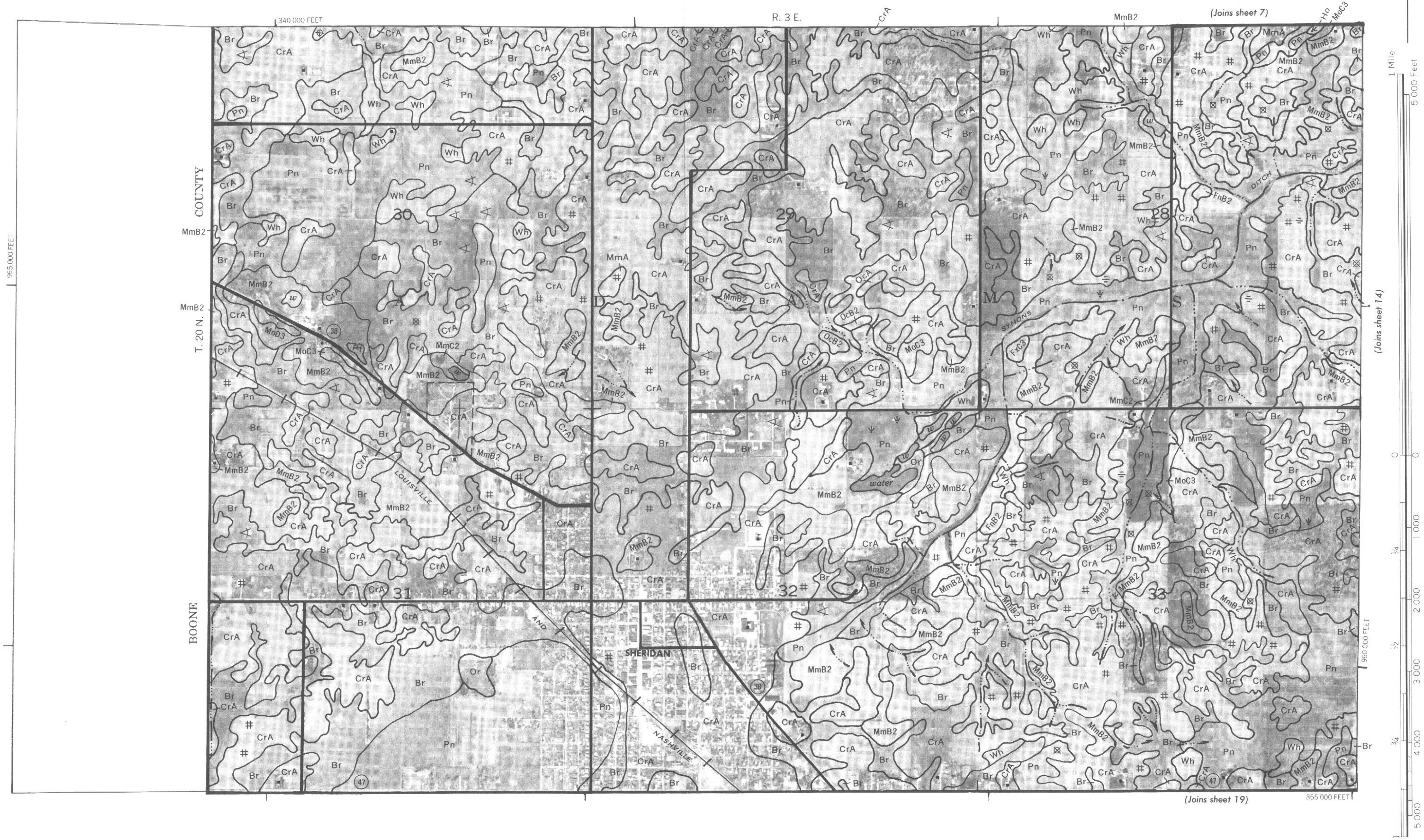
12

HAMILTON COUNTY, INDIANA — SHEET NUMBER 12



HAMILTON COUNTY, INDIANA NO. 12

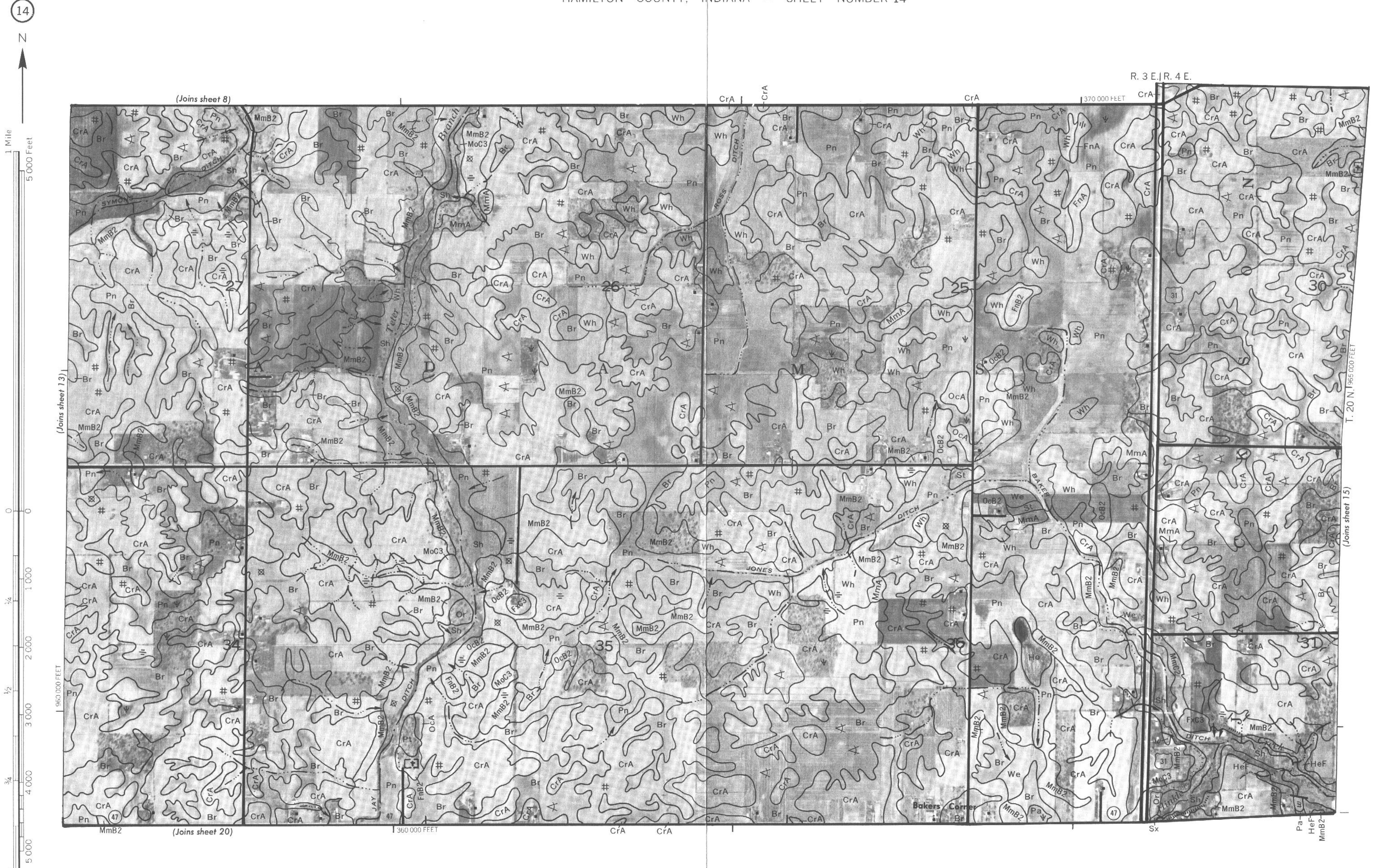
13



HAMILTON COUNTY, INDIANA NO. 13

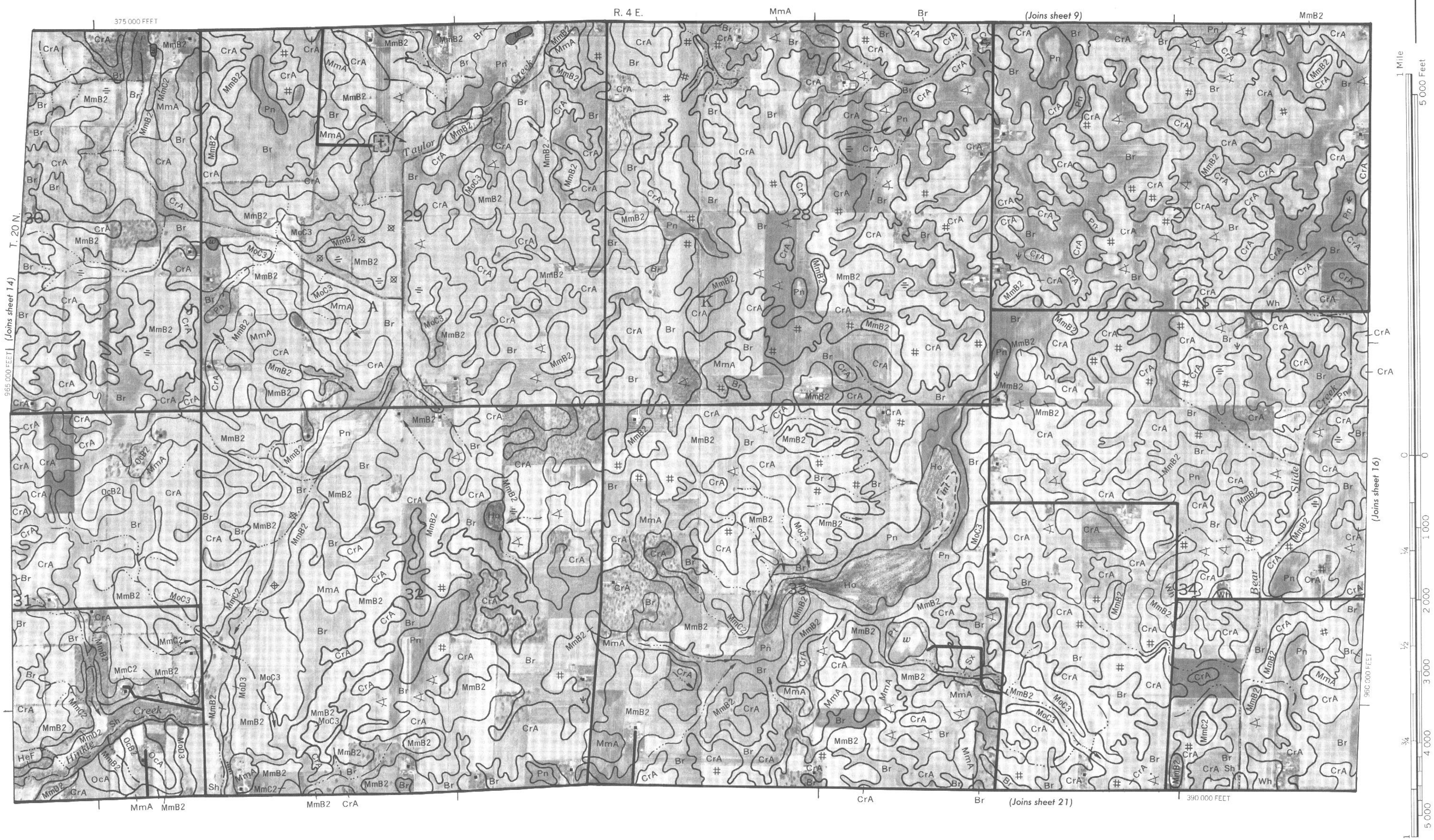
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA — SHEET NUMBER 14



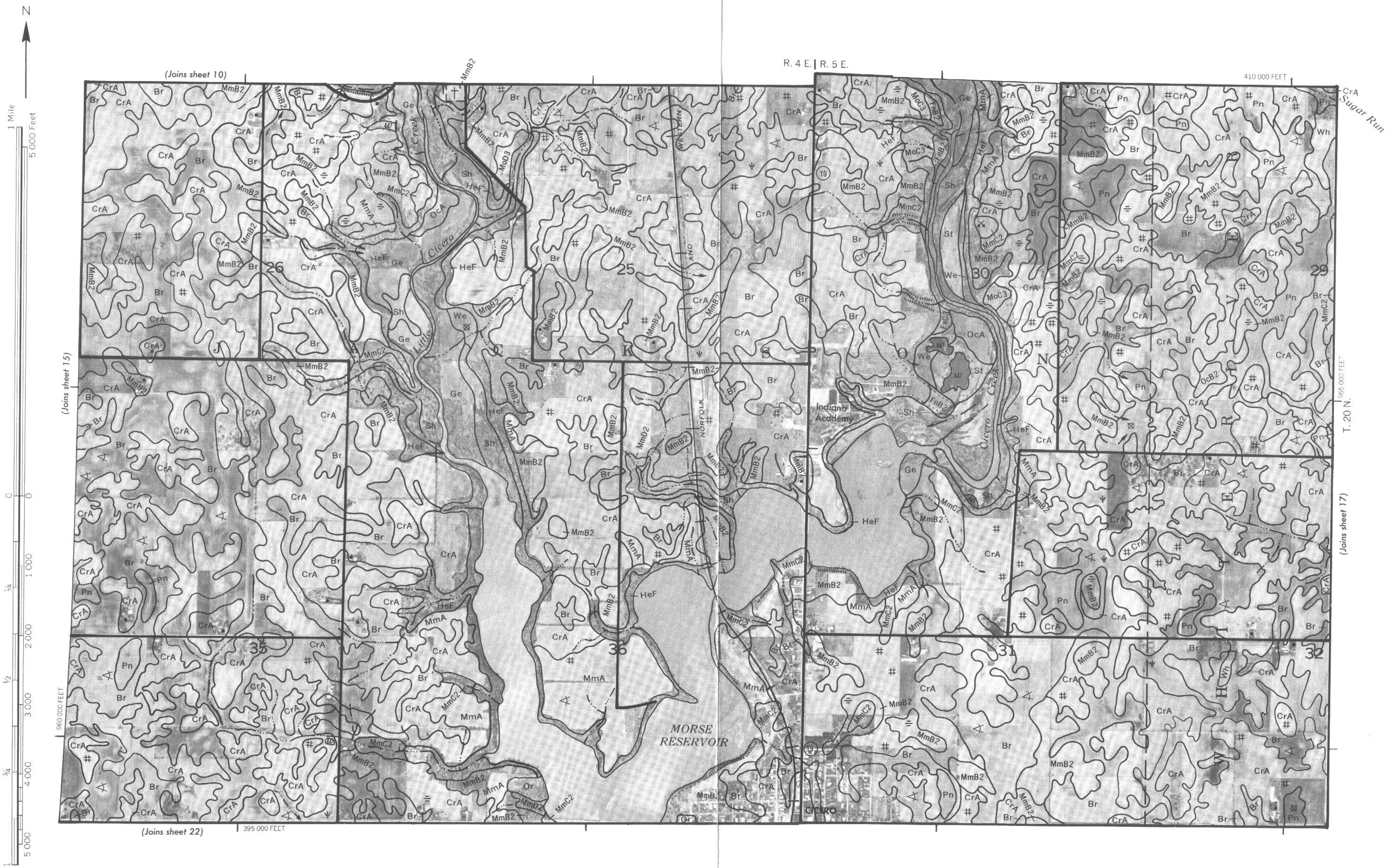
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 14

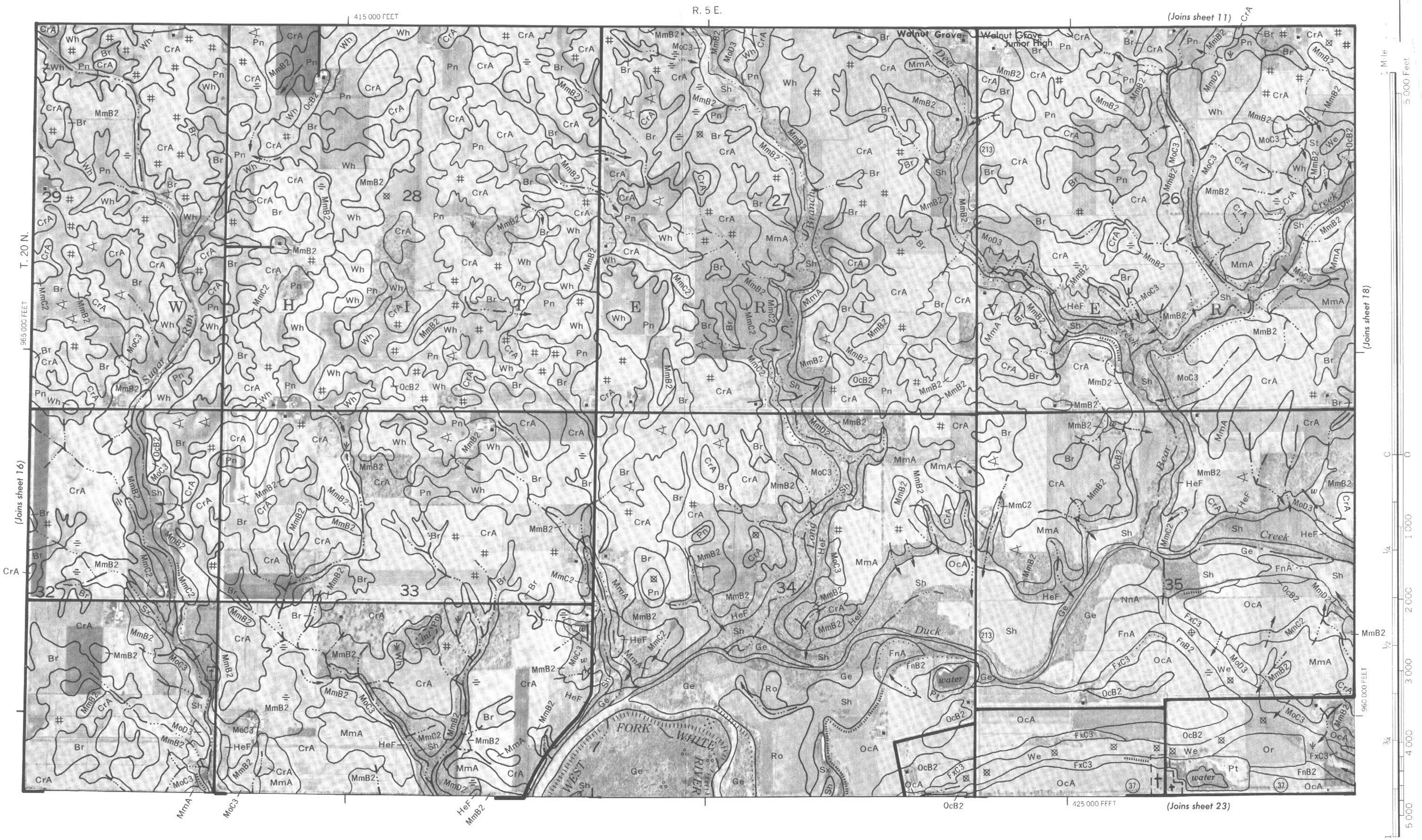


HAMILTON COUNTY, INDIANA NO. 15

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

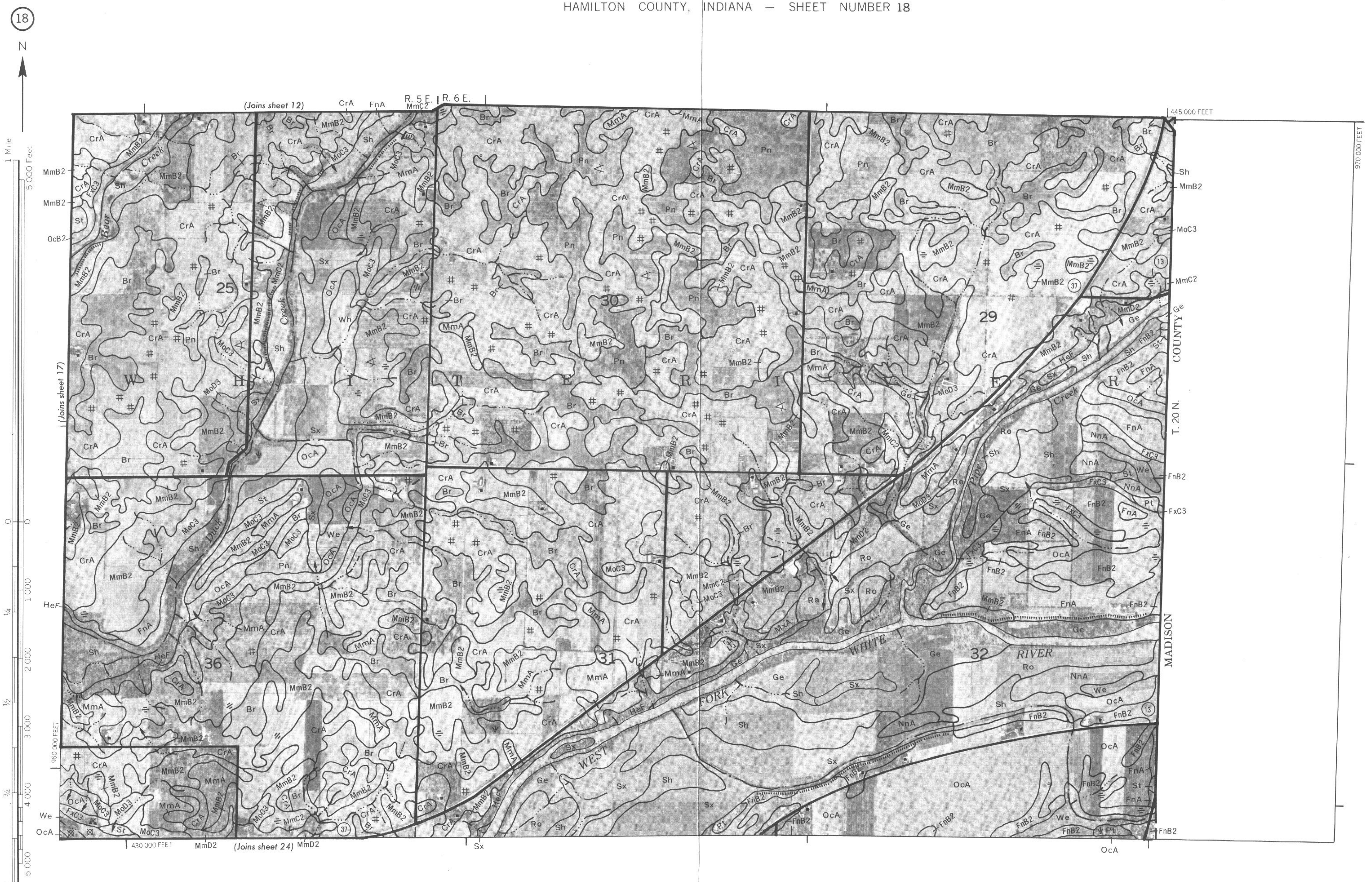


HAMILTON COUNTY, INDIANA NO. 16



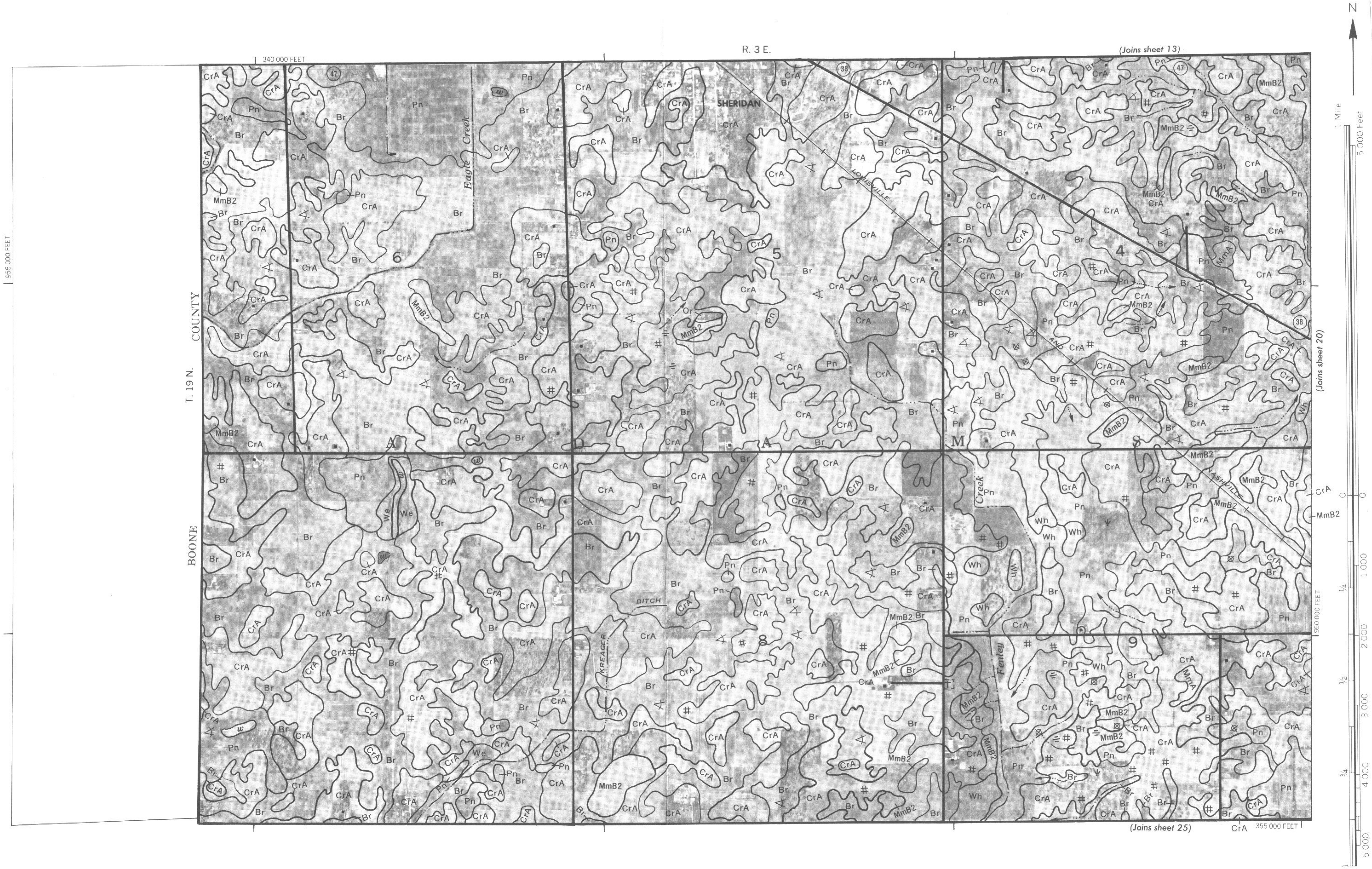
HAMILTON COUNTY, INDIANA NO. 17

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



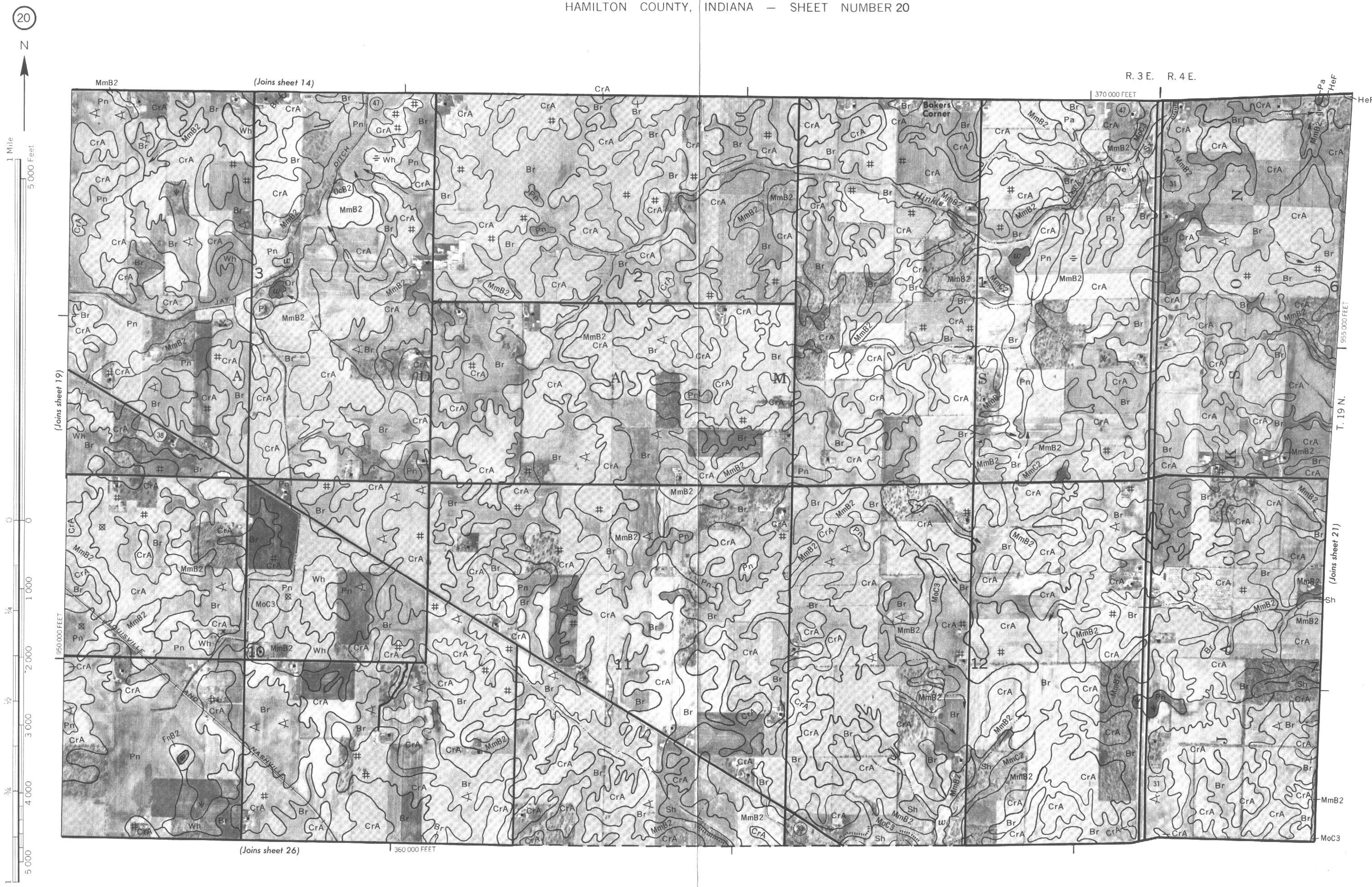
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 18

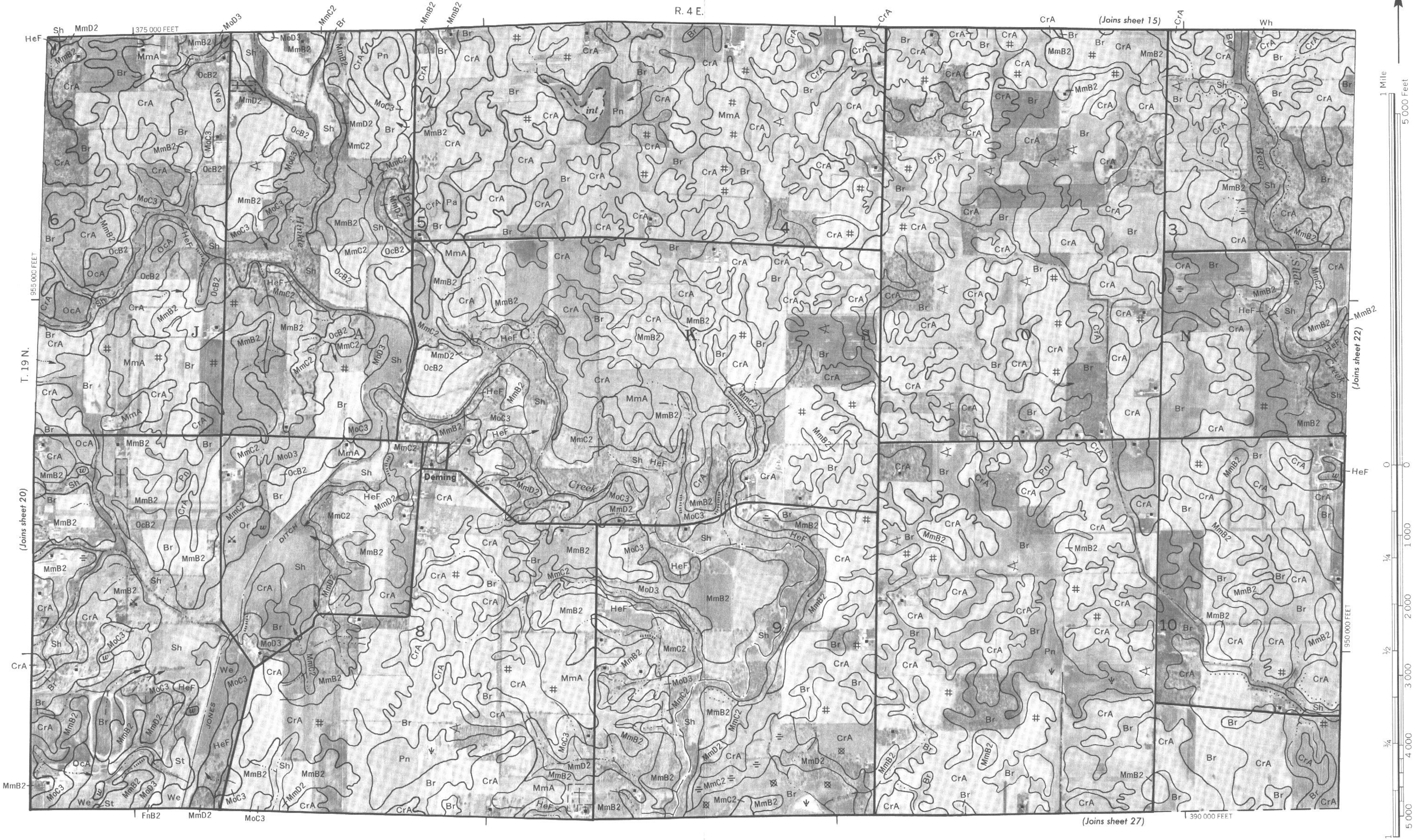


HAMILTON COUNTY, INDIANA NO. 19

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

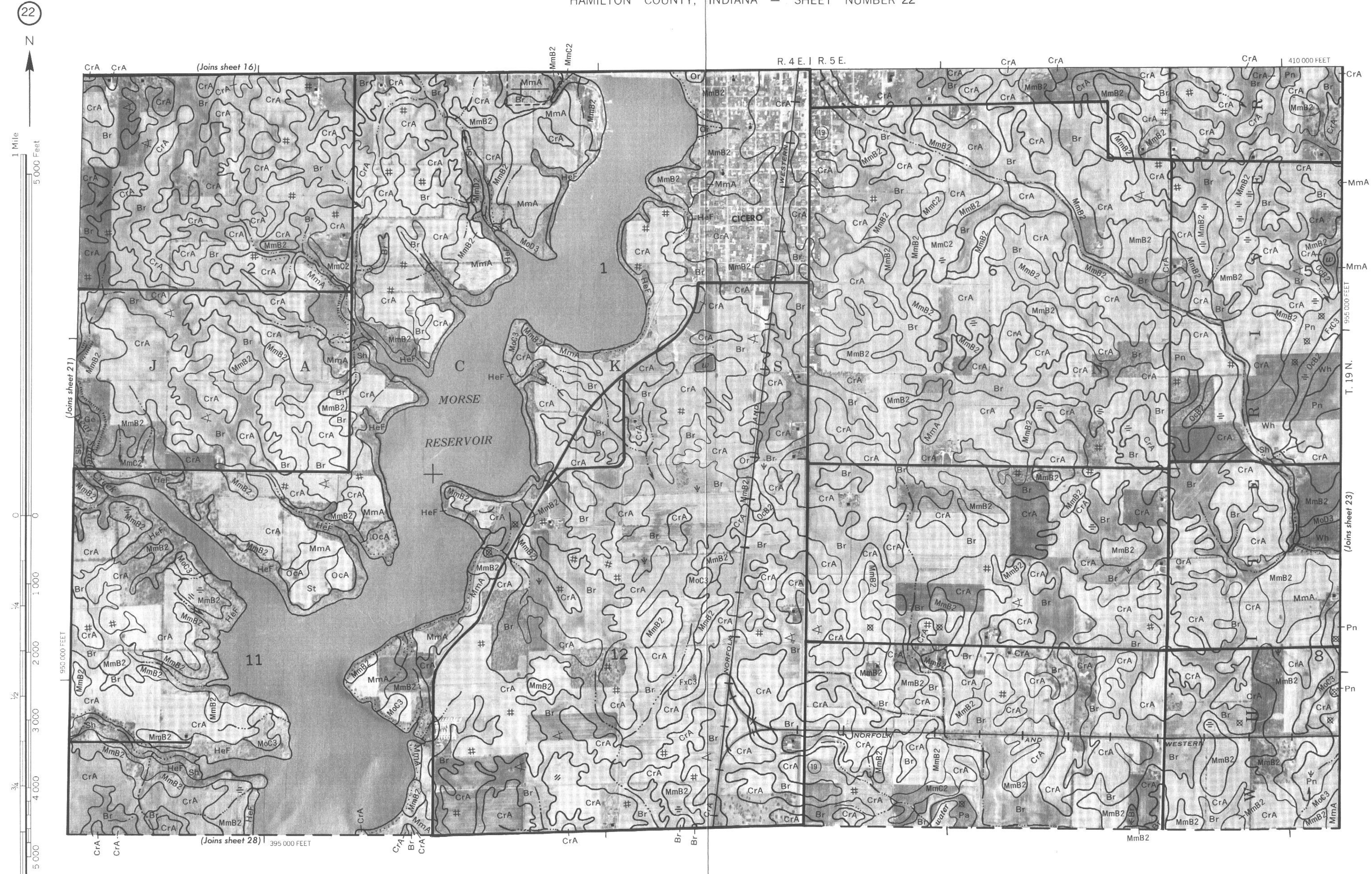


This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HAMILTON COUNTY, INDIANA NO. 21

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

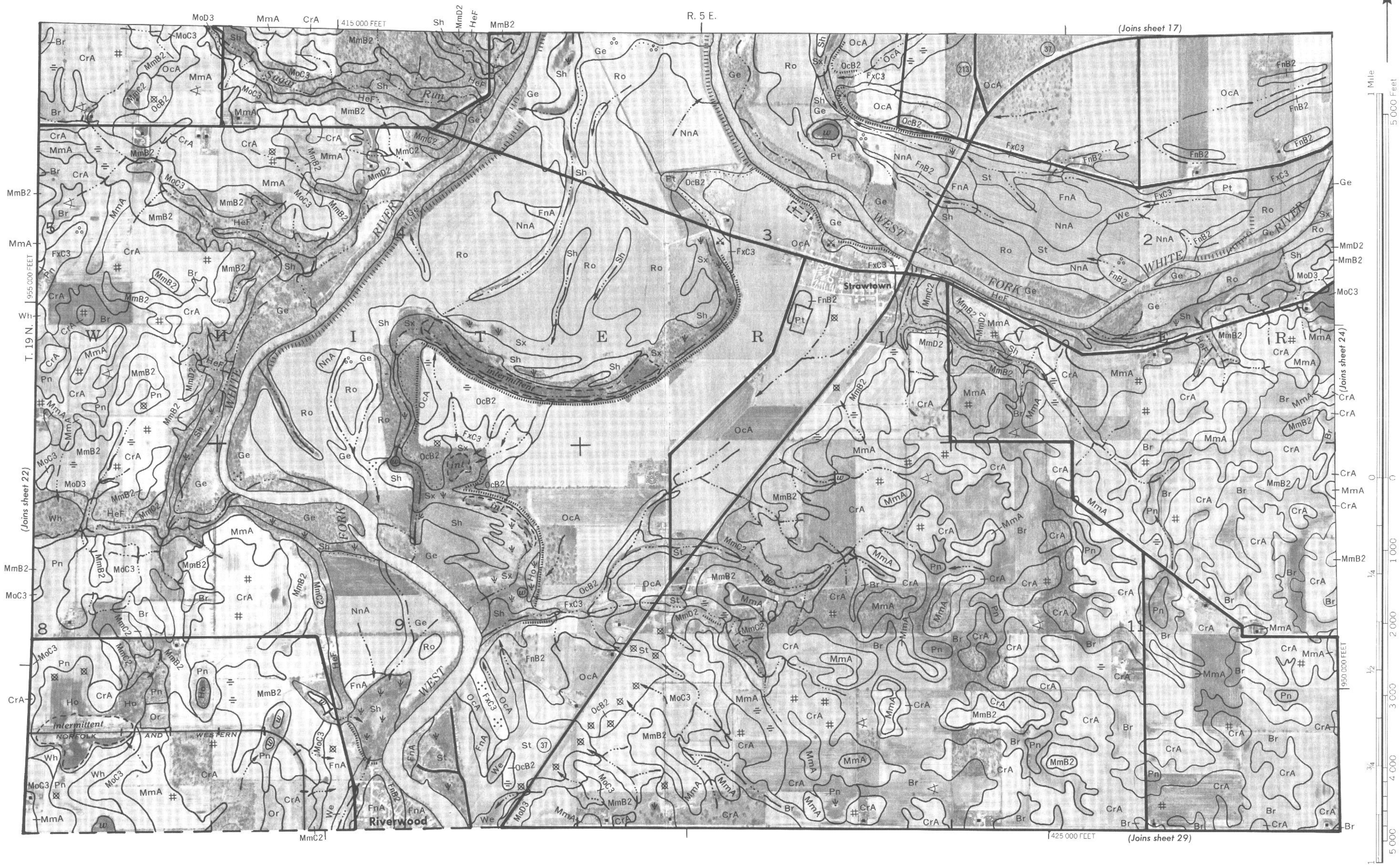


This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 22

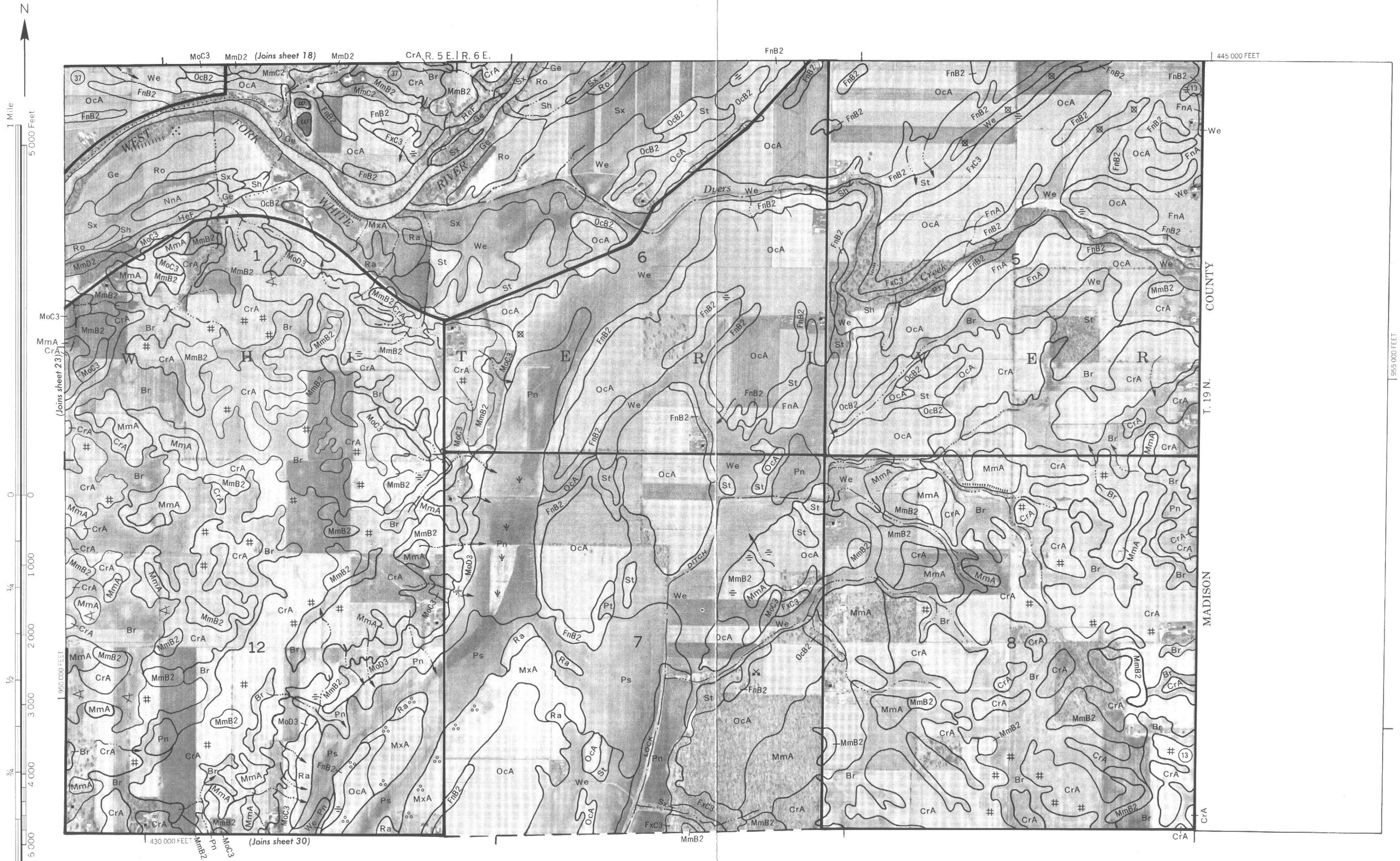
23

N

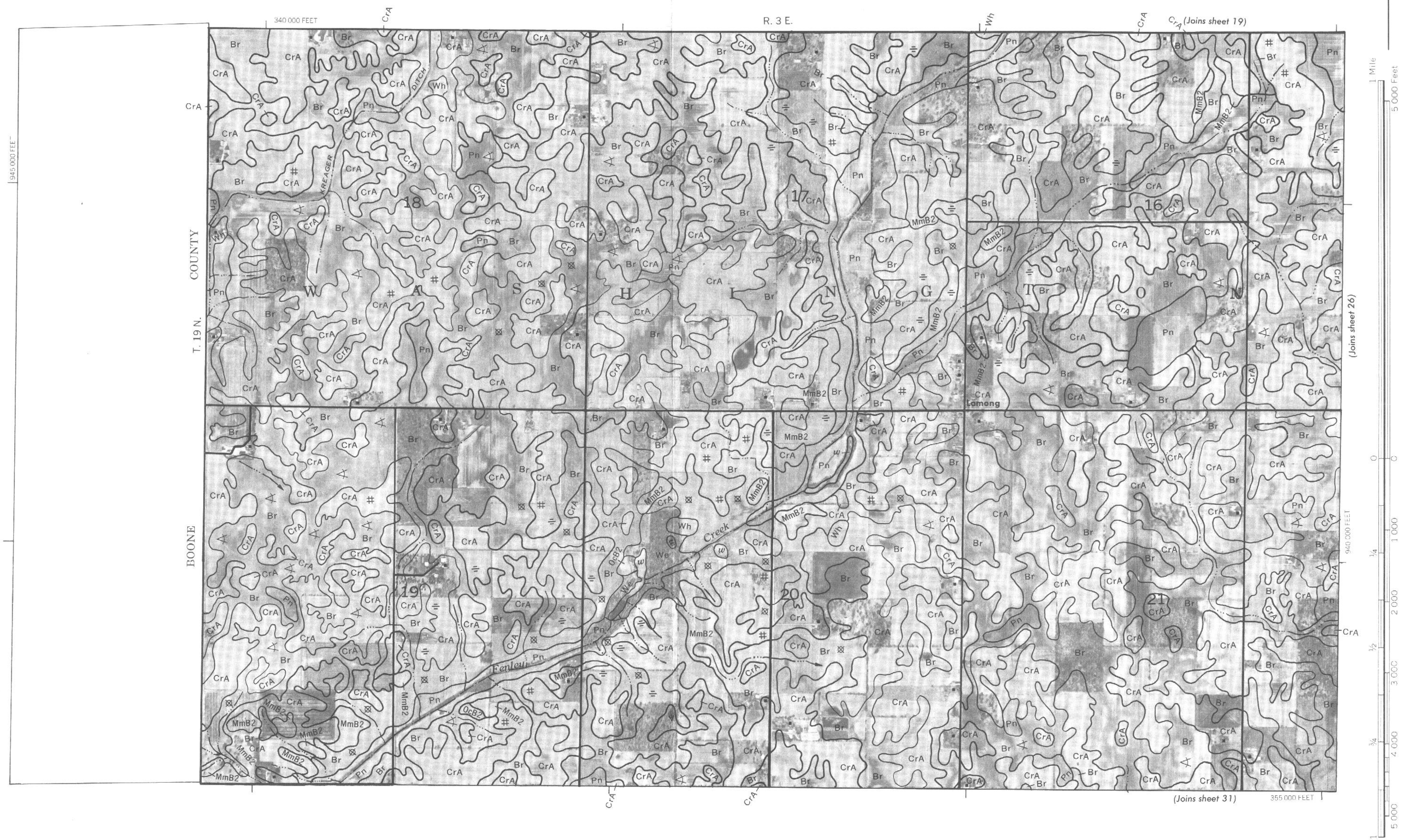


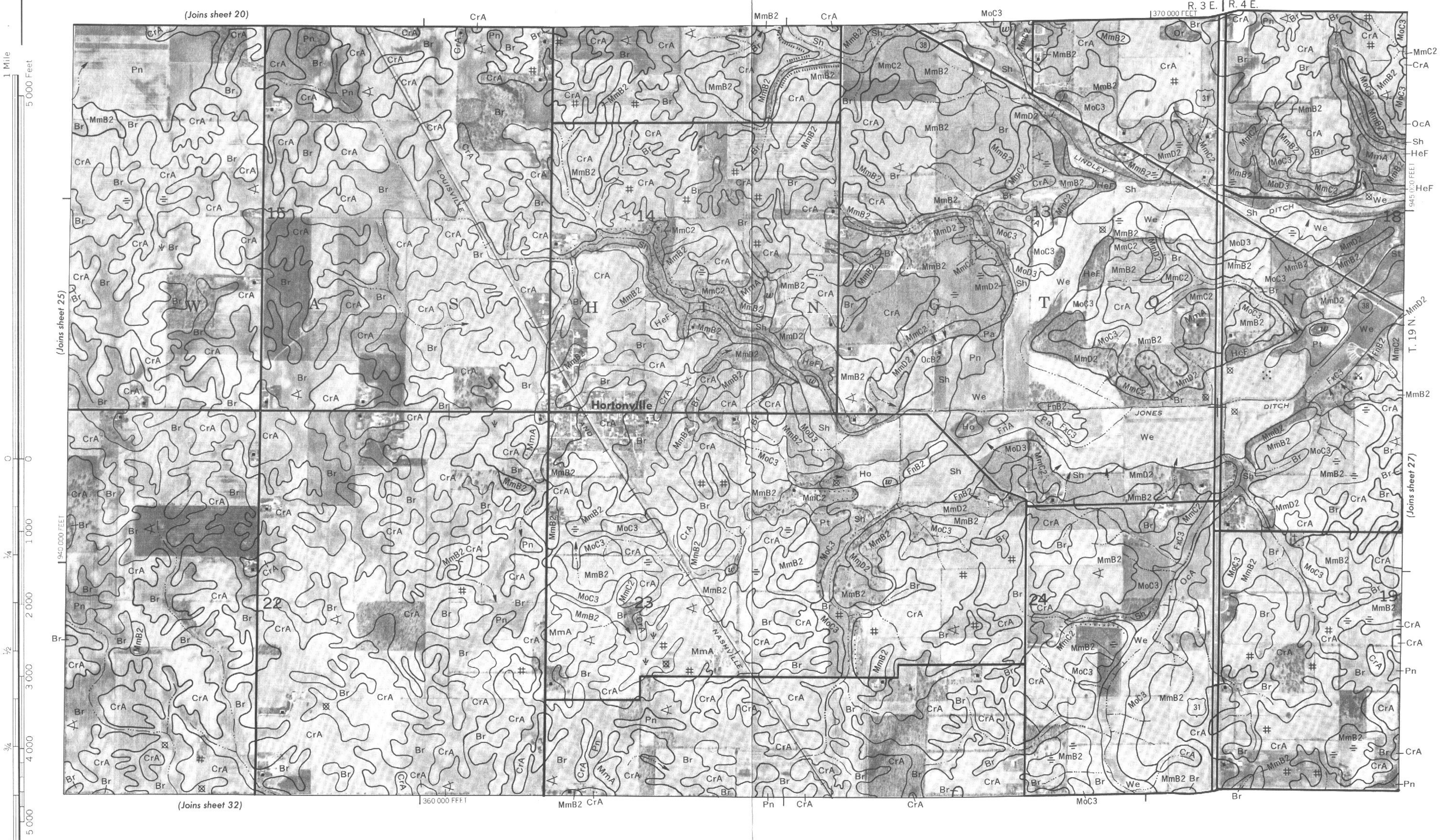
HAMILTON COUNTY, INDIANA NO. 23

HAMILTON COUNTY, INDIANA — SHEET NUMBER 24

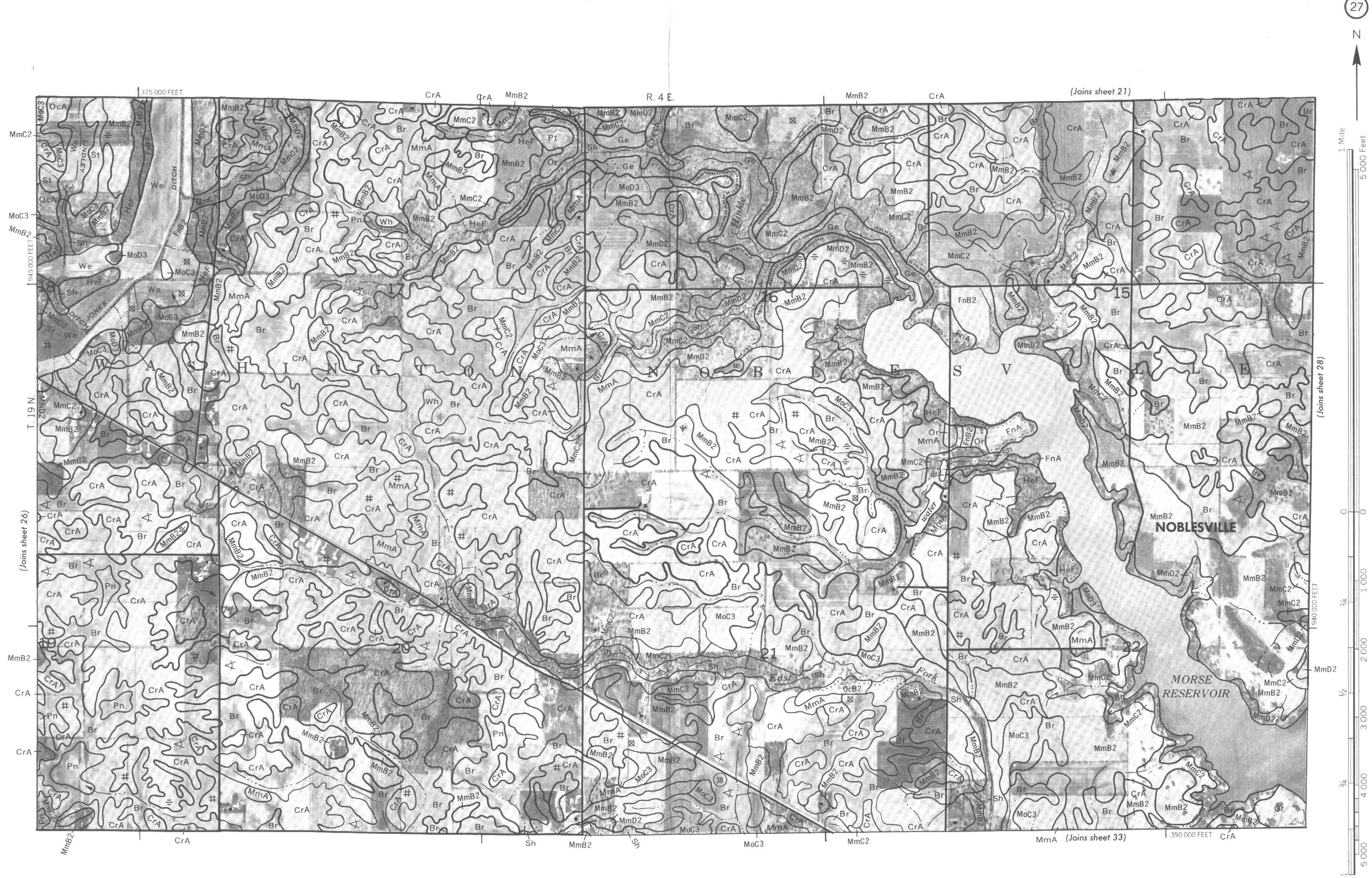


HAMILTON COUNTY, INDIANA NO. 24


N
340 000 FEET
R. 3 E.
(Joins sheet 19)
(Joins sheet 26)
(Joins sheet 31)
355 000 FEET
945 000 FEET
940 000 FEET
T. 19 N.
BOONE COUNTY
W A S H I N G T O N
18
17
16
19
20
21
Lamong
Fenleur Creek
KREAGER DITCH
1 Mile
5 000 Feet

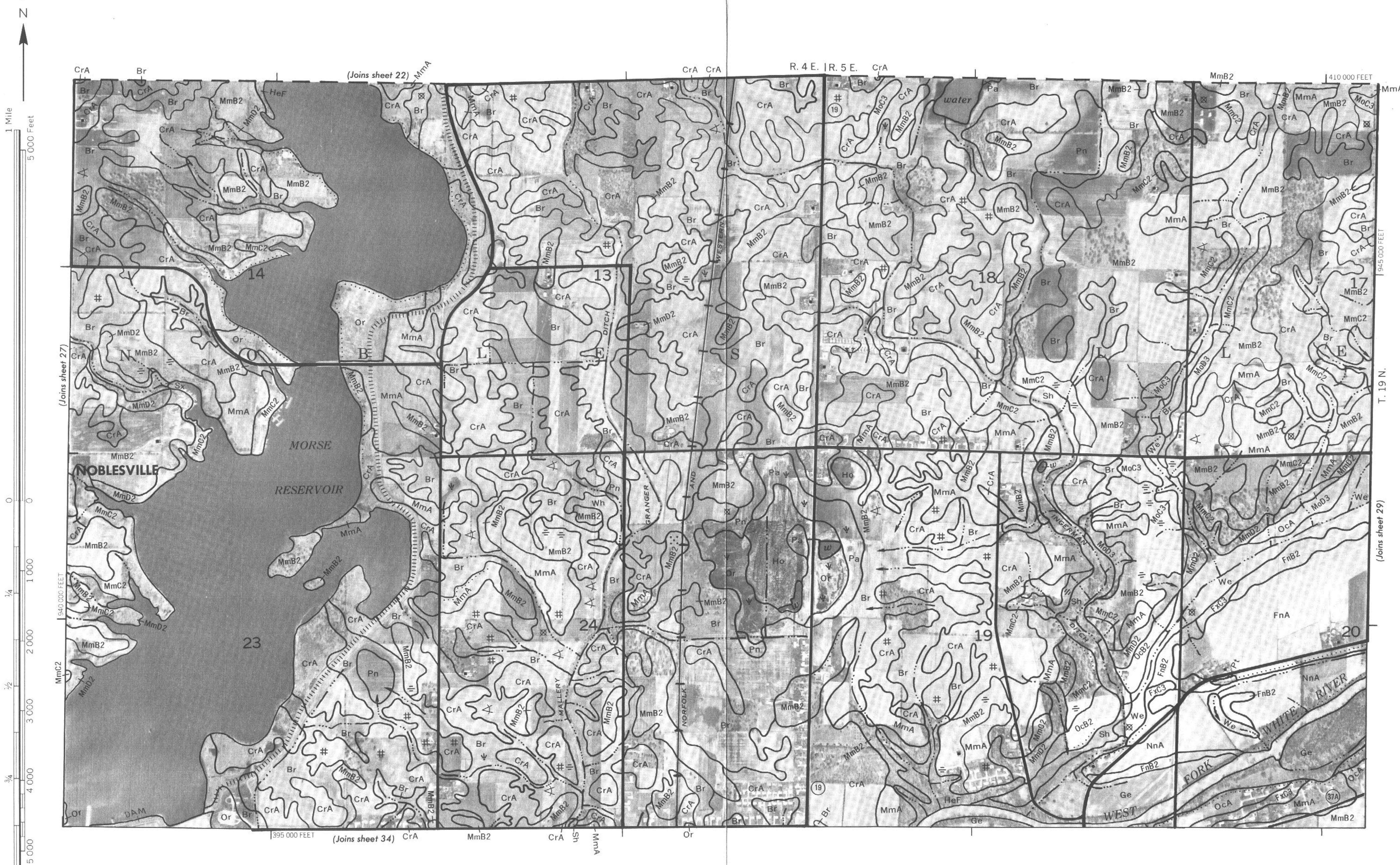


HAMILTON COUNTY, INDIANA NO. 26



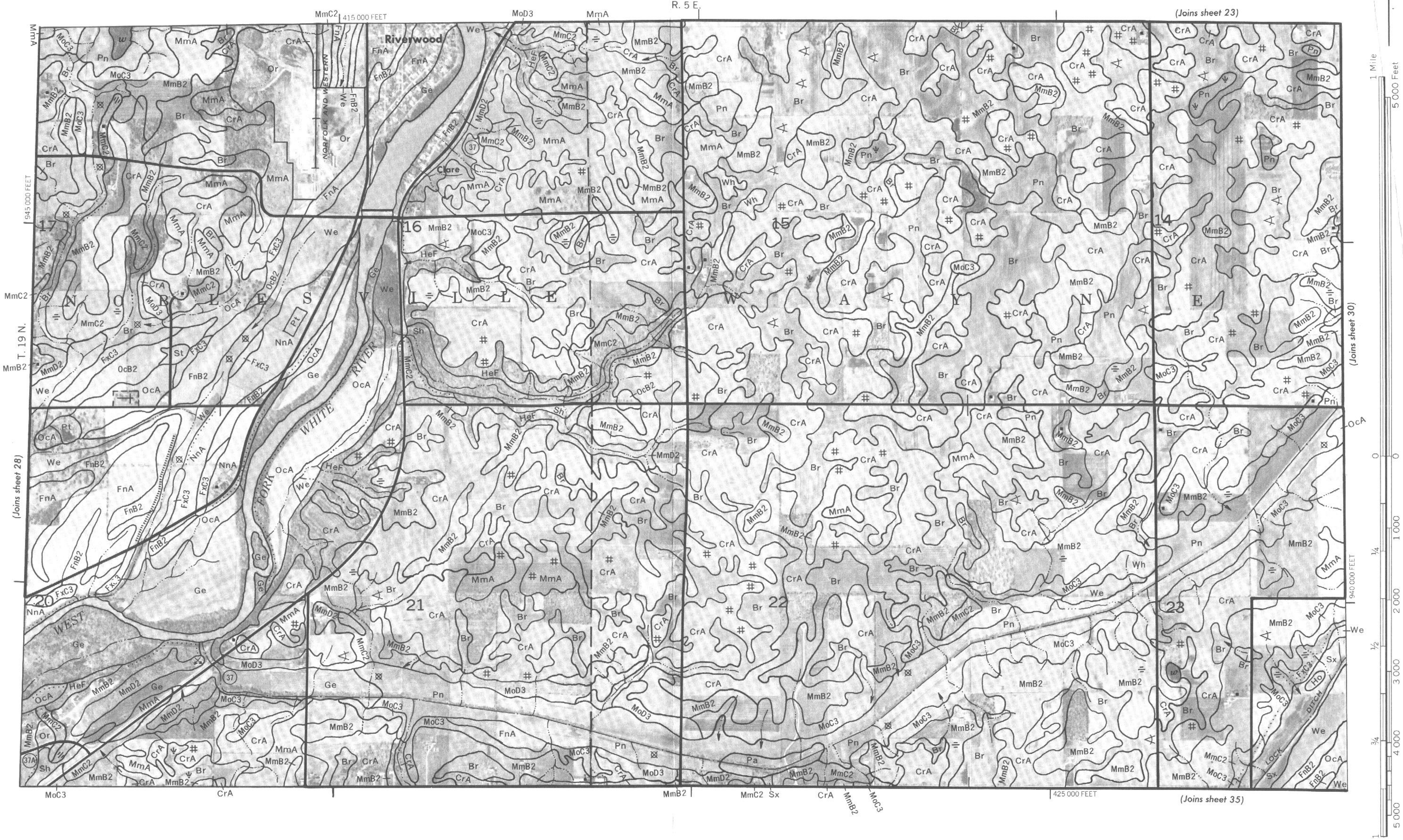
HAMILTON COUNTY, INDIANA NO. 27

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

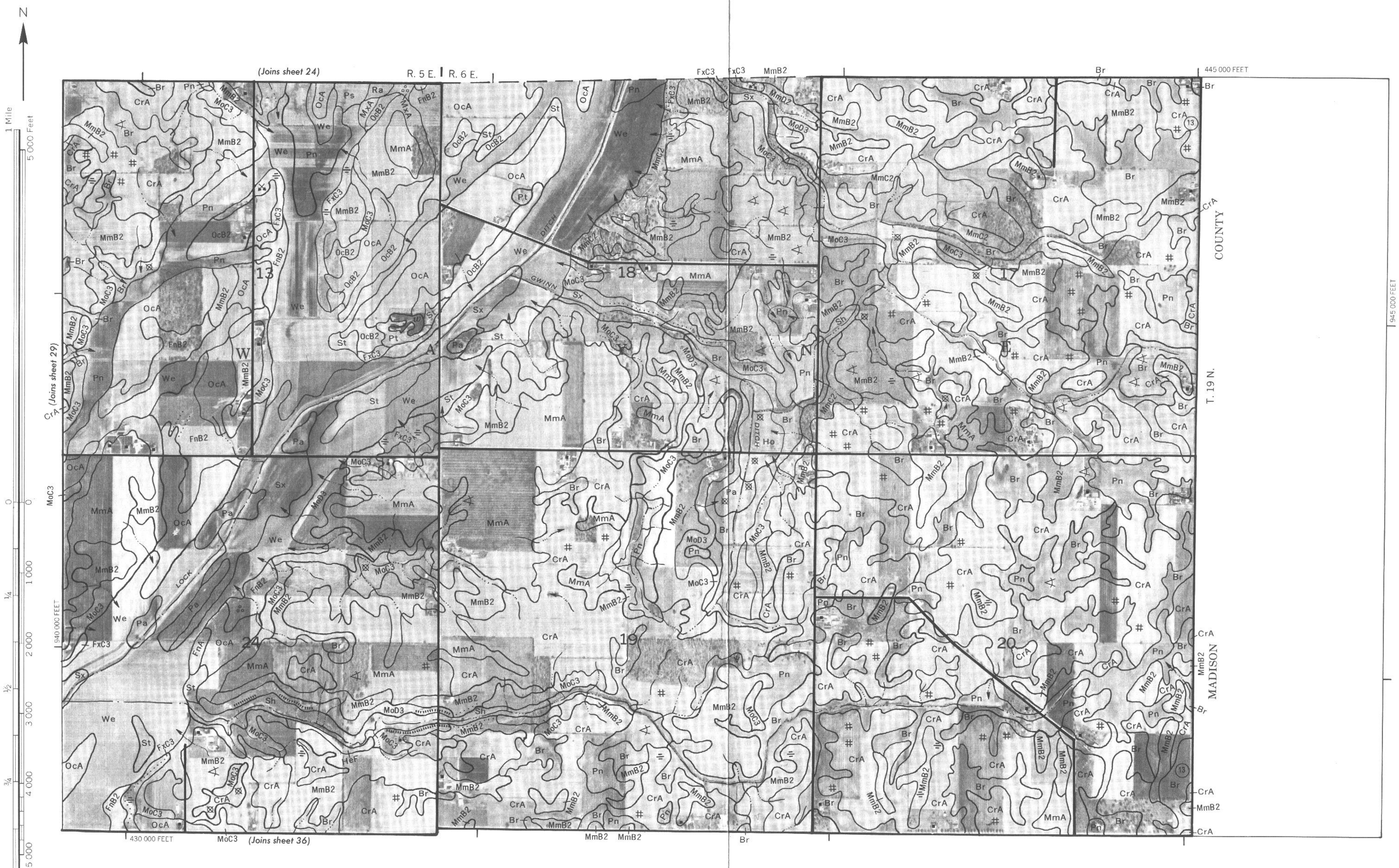
29



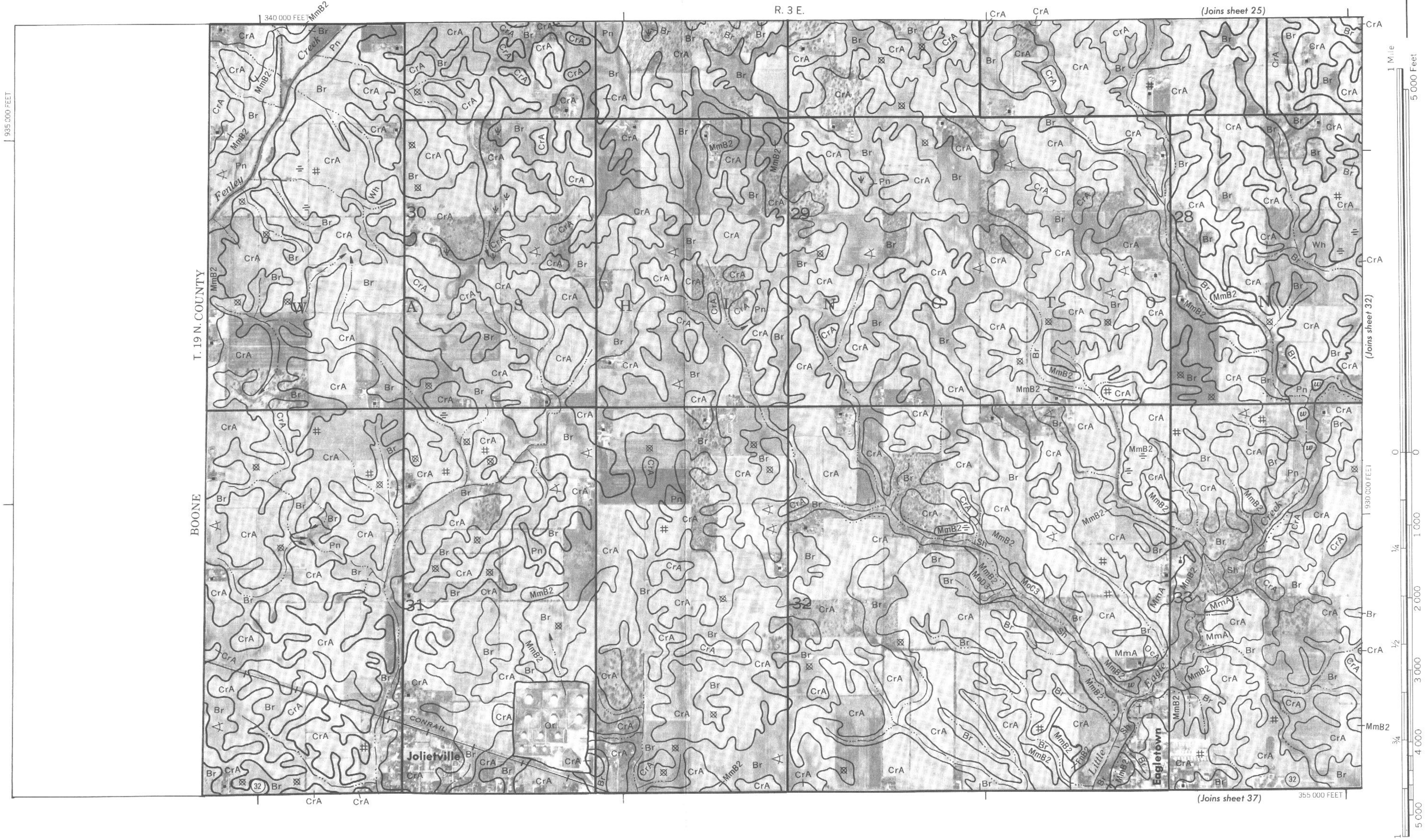
HAMILTON COUNTY, INDIANA NO. 29

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA — SHEET NUMBER 30



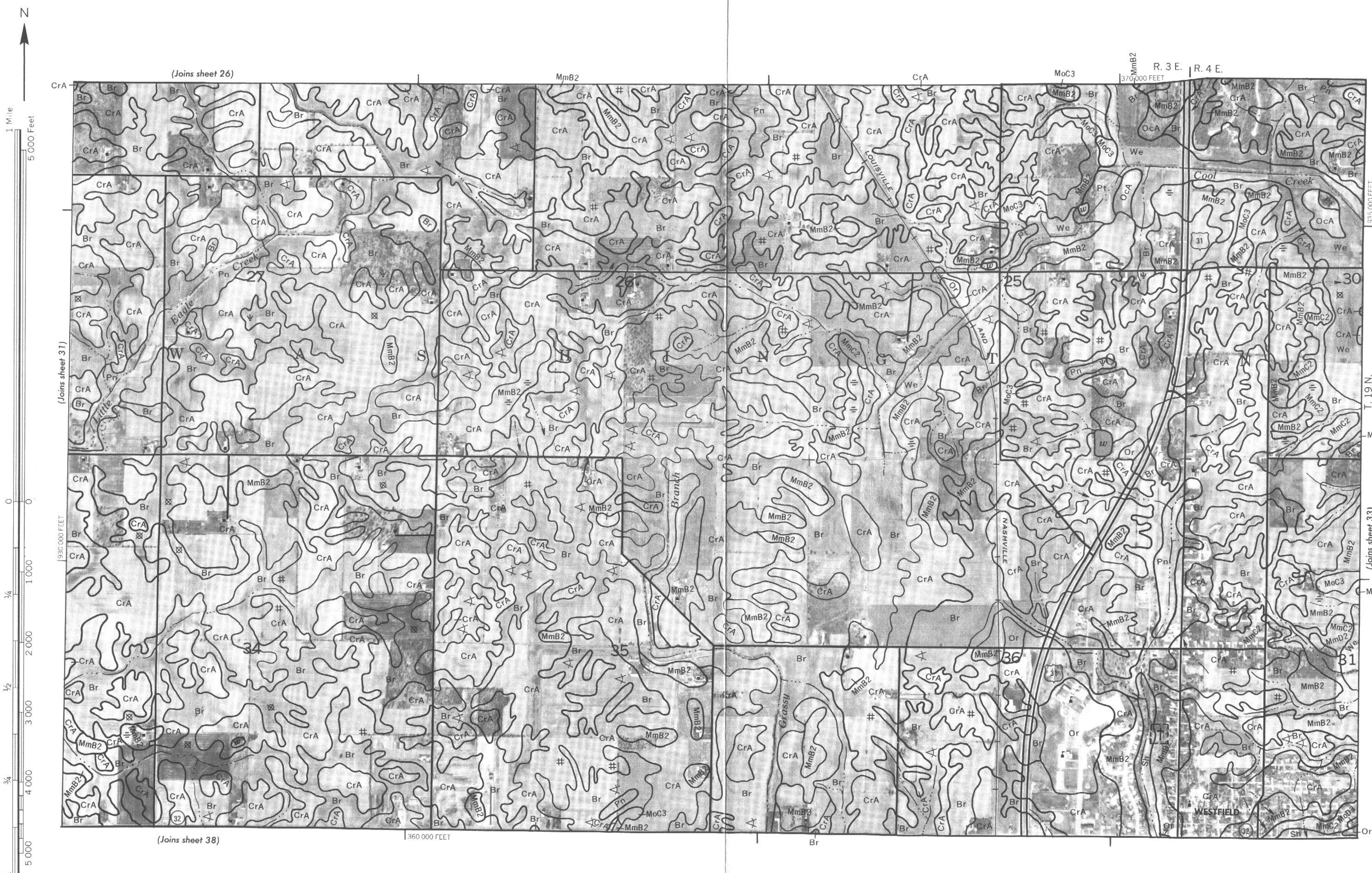
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HAMILTON COUNTY, INDIANA NO. 31

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

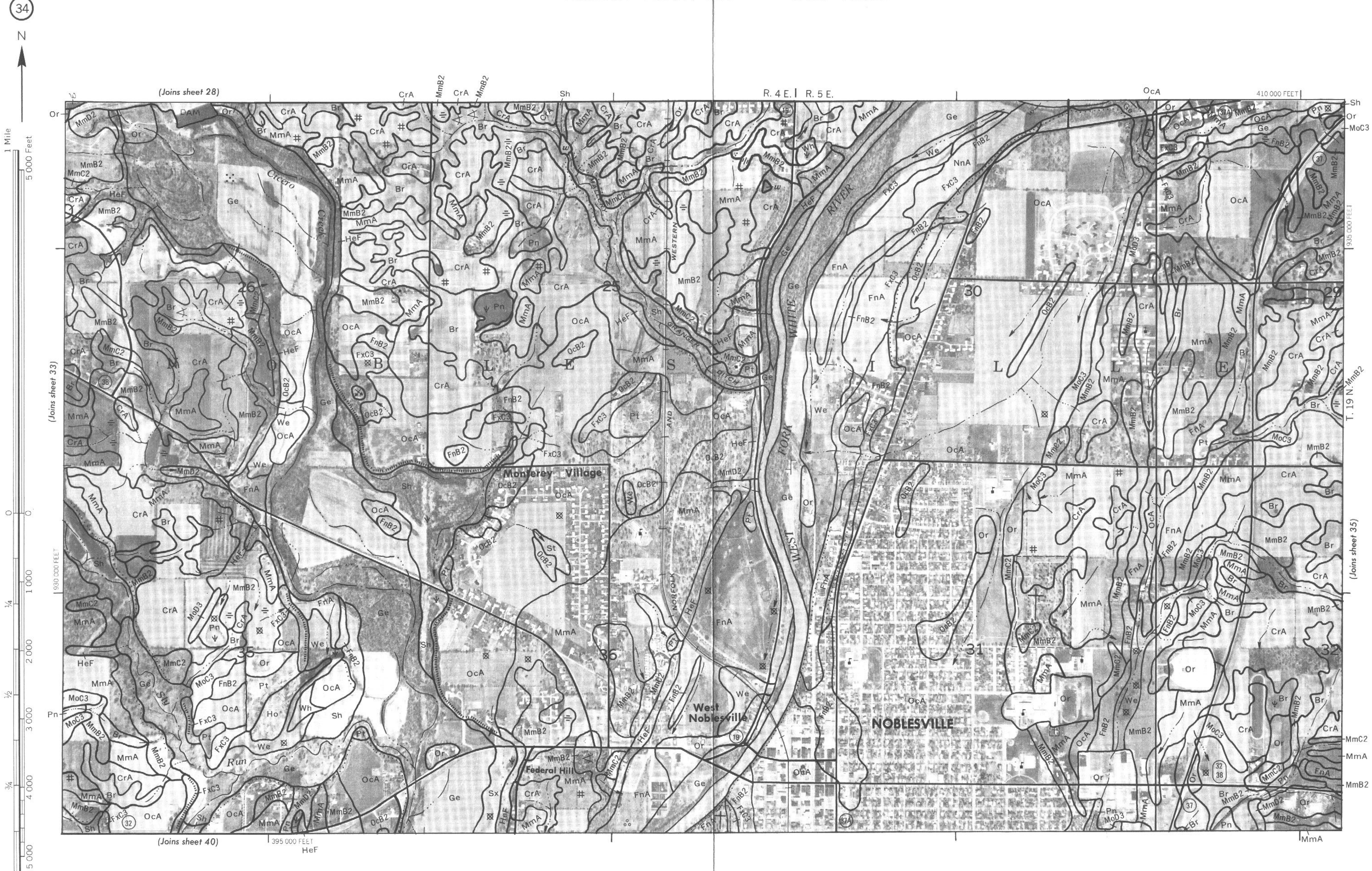
HAMILTON COUNTY, INDIANA — SHEET NUMBER 32



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

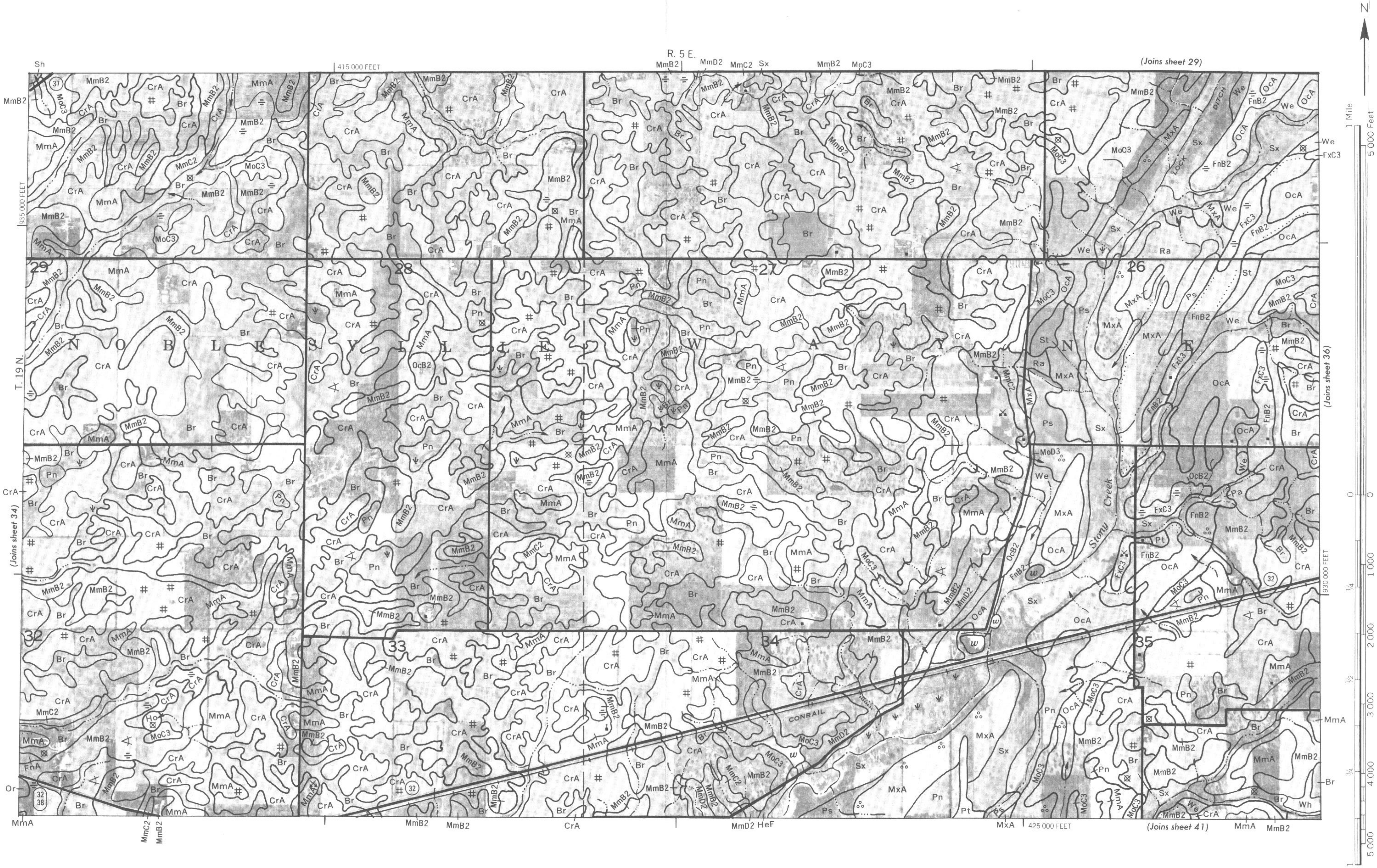
HAMILTON COUNTY, INDIANA NO. 33

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



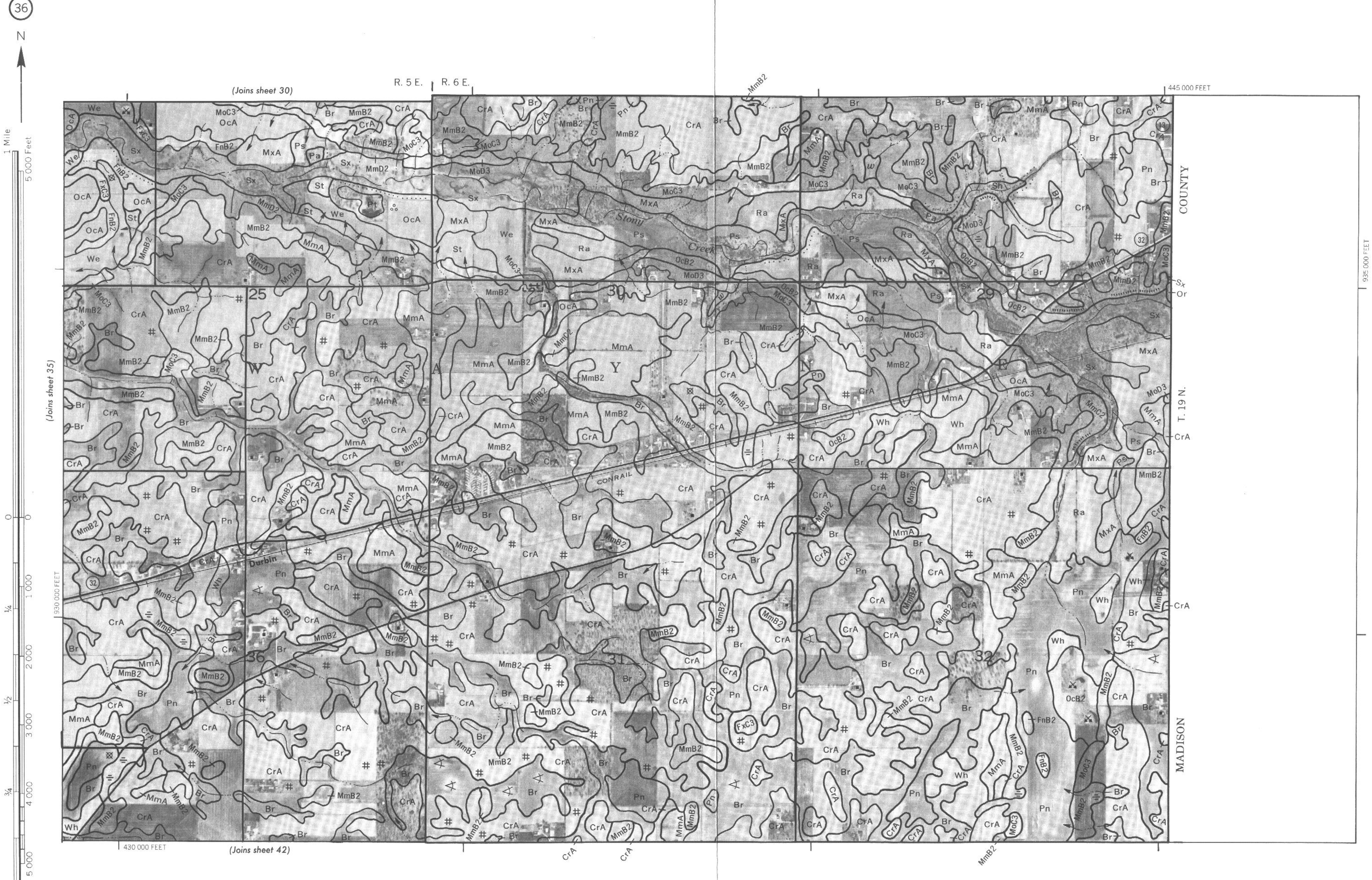
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 34



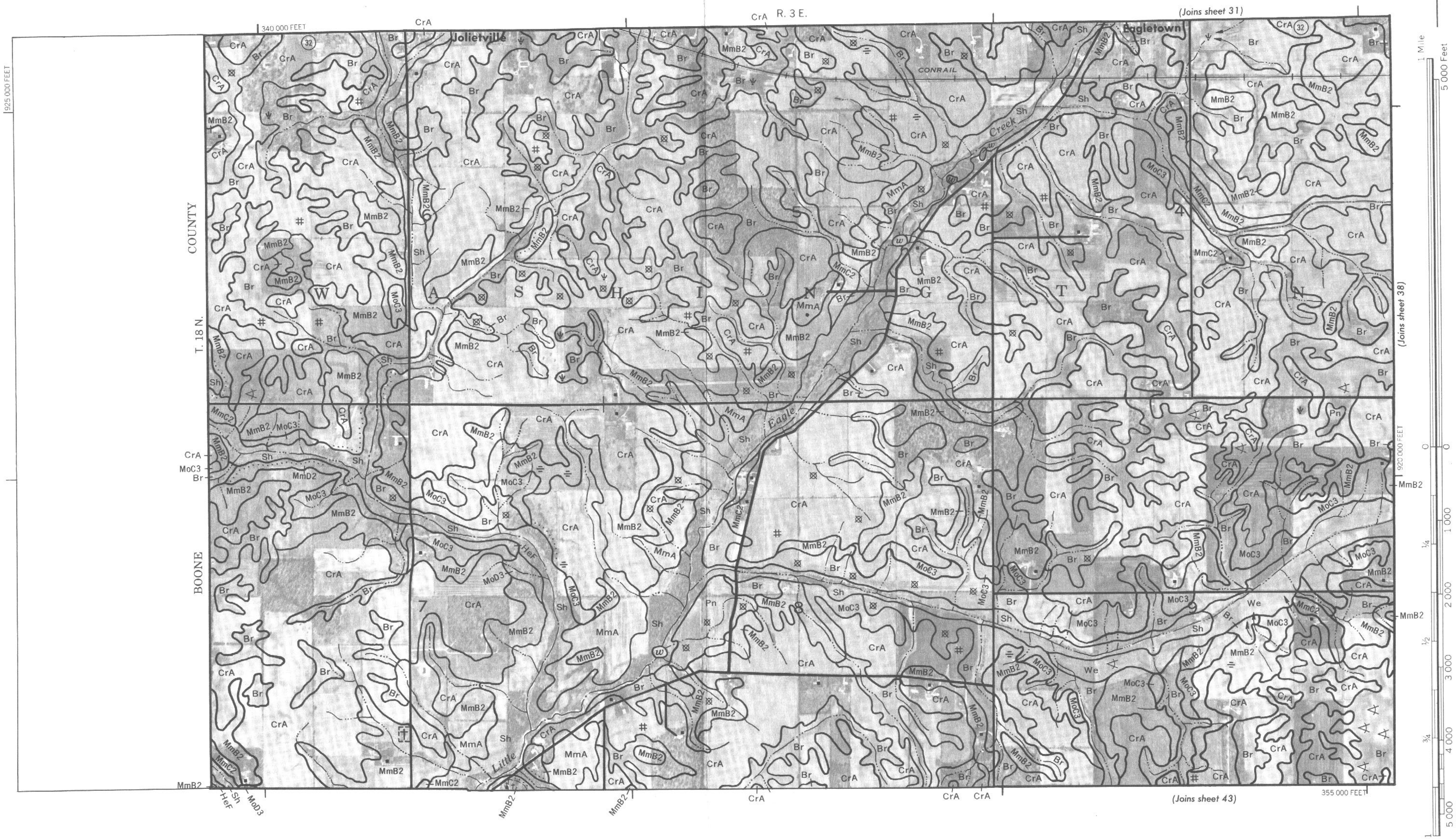
HAMILTON COUNTY, INDIANA NO. 35

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 36



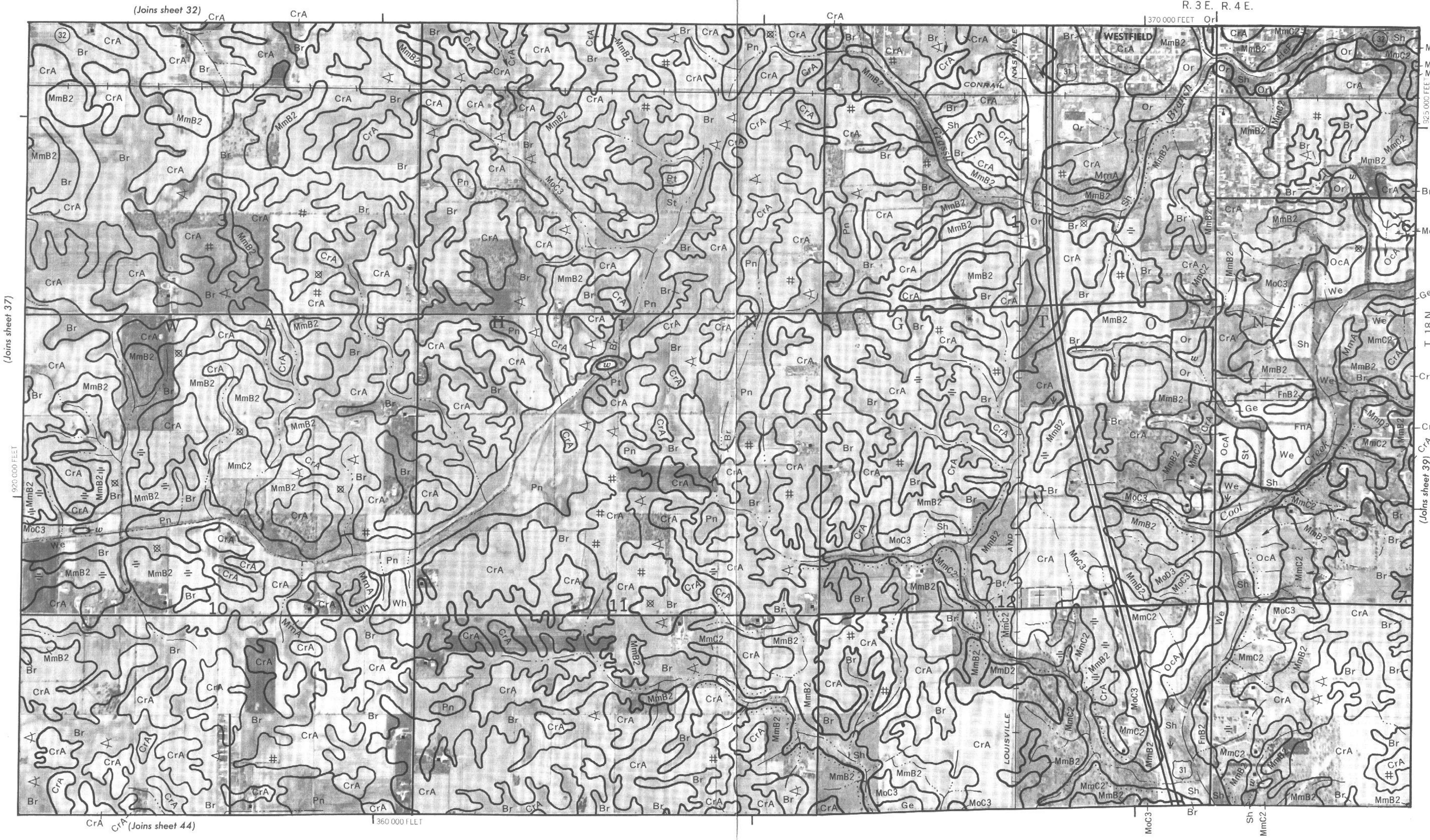
HAMILTON COUNTY, INDIANA NO. 37

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

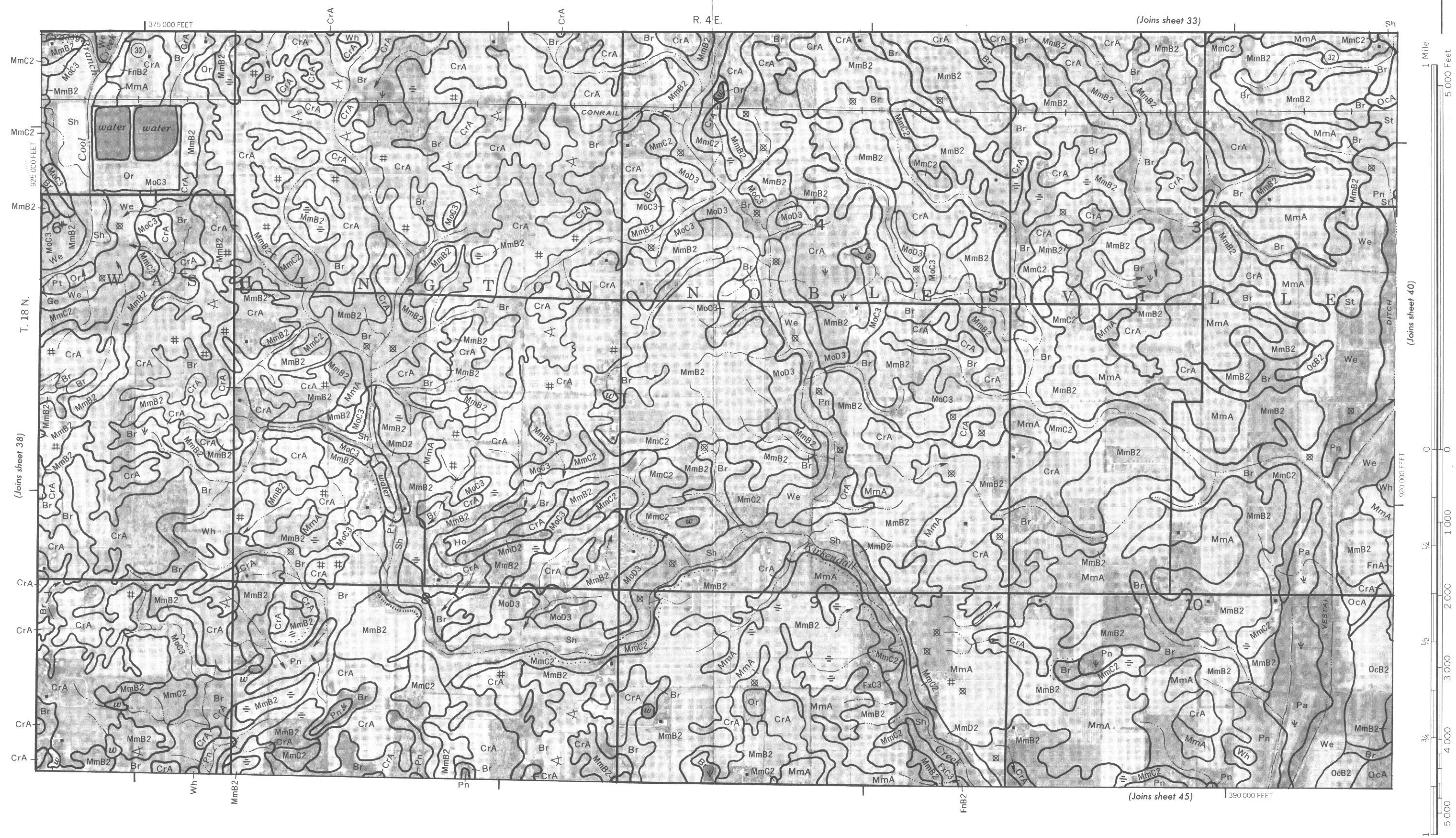
HAMILTON COUNTY, INDIANA — SHEET NUMBER 38

N

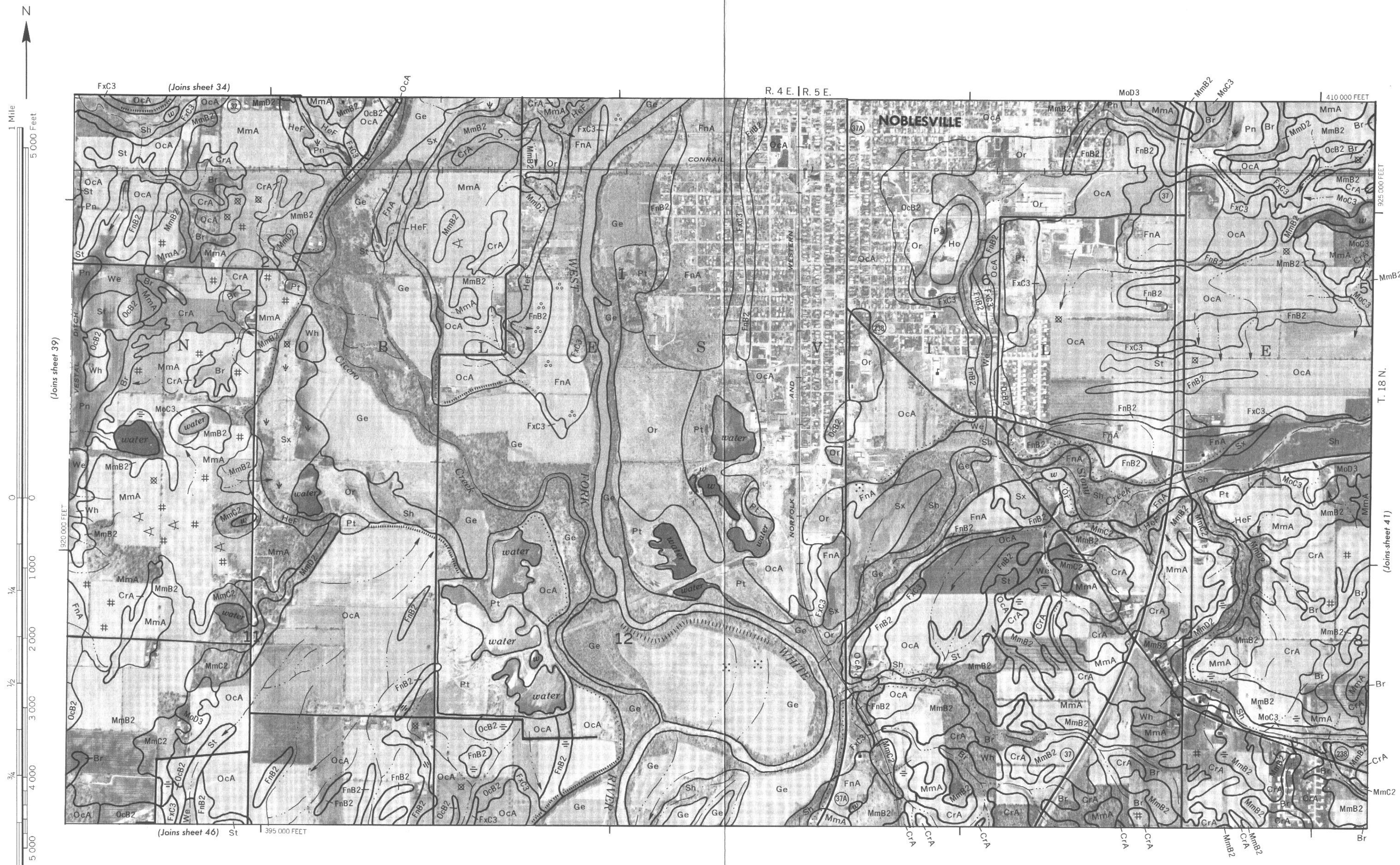
1 Mile 5 000 Feet 0 1 000 2 000 3 000 4 000 5 000 ¼ ½ ¾



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


39
N
(Joins sheet 33)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 45)
R. 4 E.
T. 18 N.
375 000 FEET
390 000 FEET
925 000 FEET
920 000 FEET
1 Mile
5 000 Feet
HAMILTON COUNTY, INDIANA NO. 39
WASHINGTON
NOBLESVILLE
CONRAIL
Cool Creek
Kirkendall Creek
VESTAL
DITCH
water

HAMILTON COUNTY, INDIANA — SHEET NUMBER 40

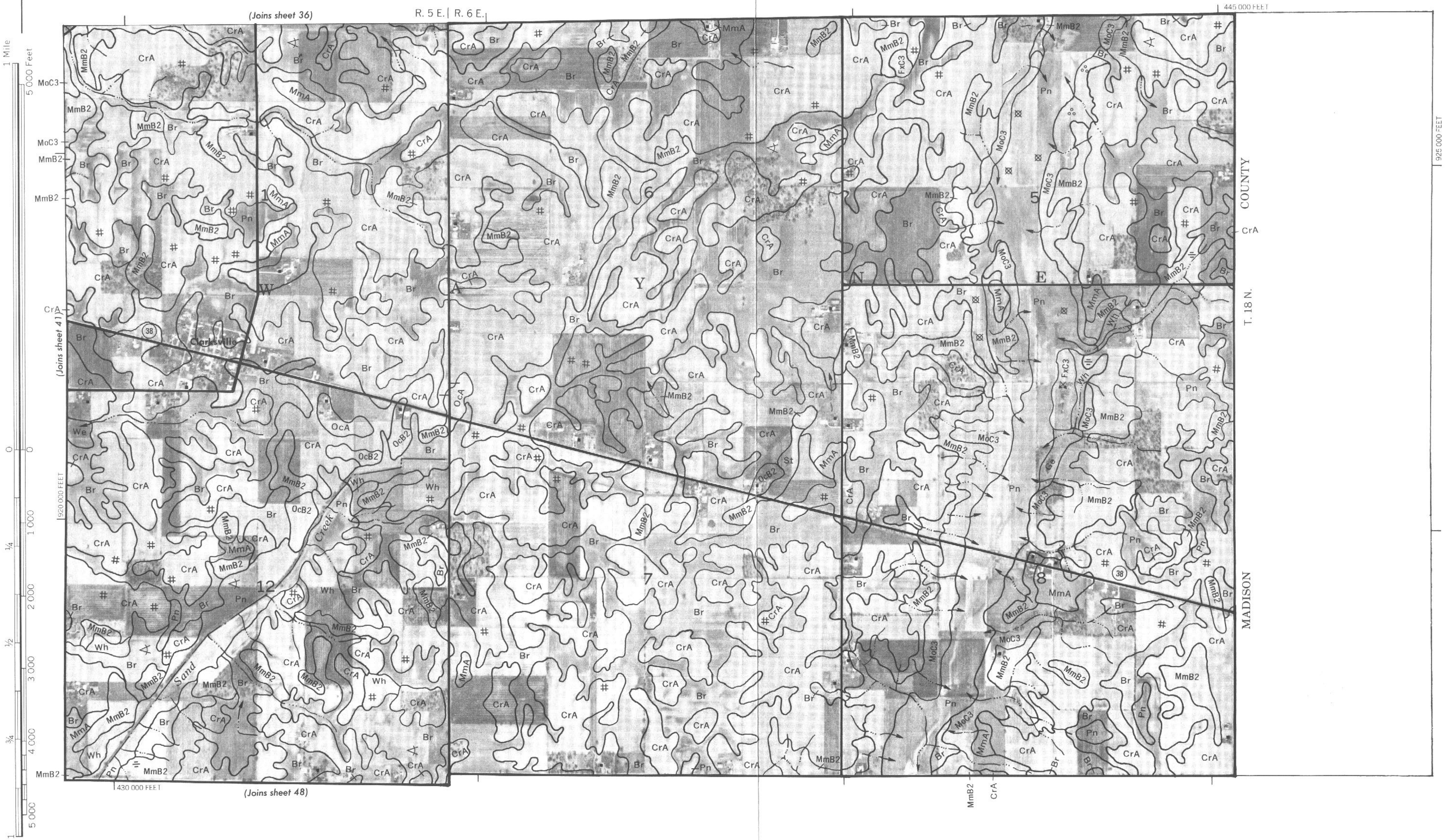


This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 40

HAMILTON COUNTY, INDIANA NO. 41

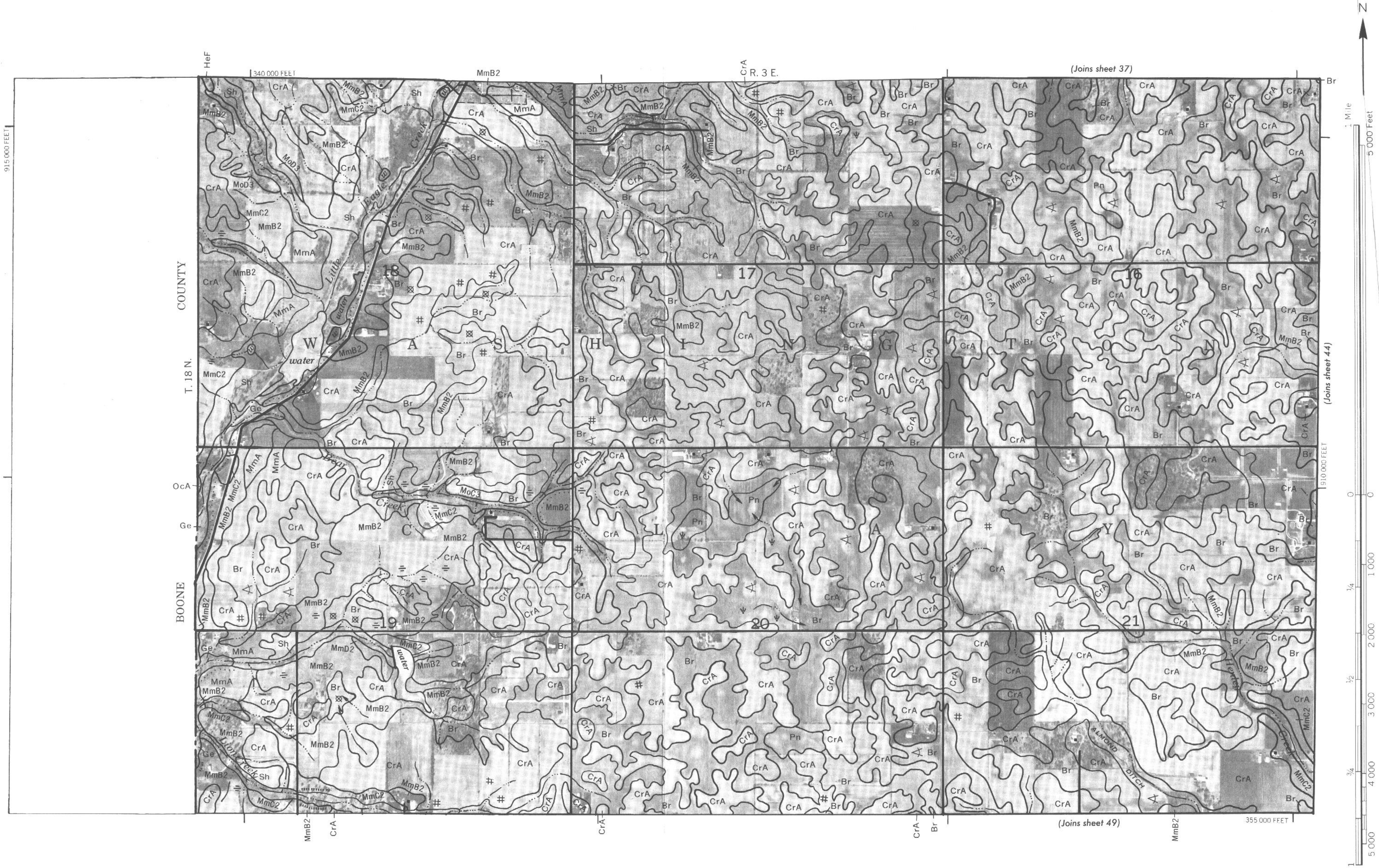
42



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

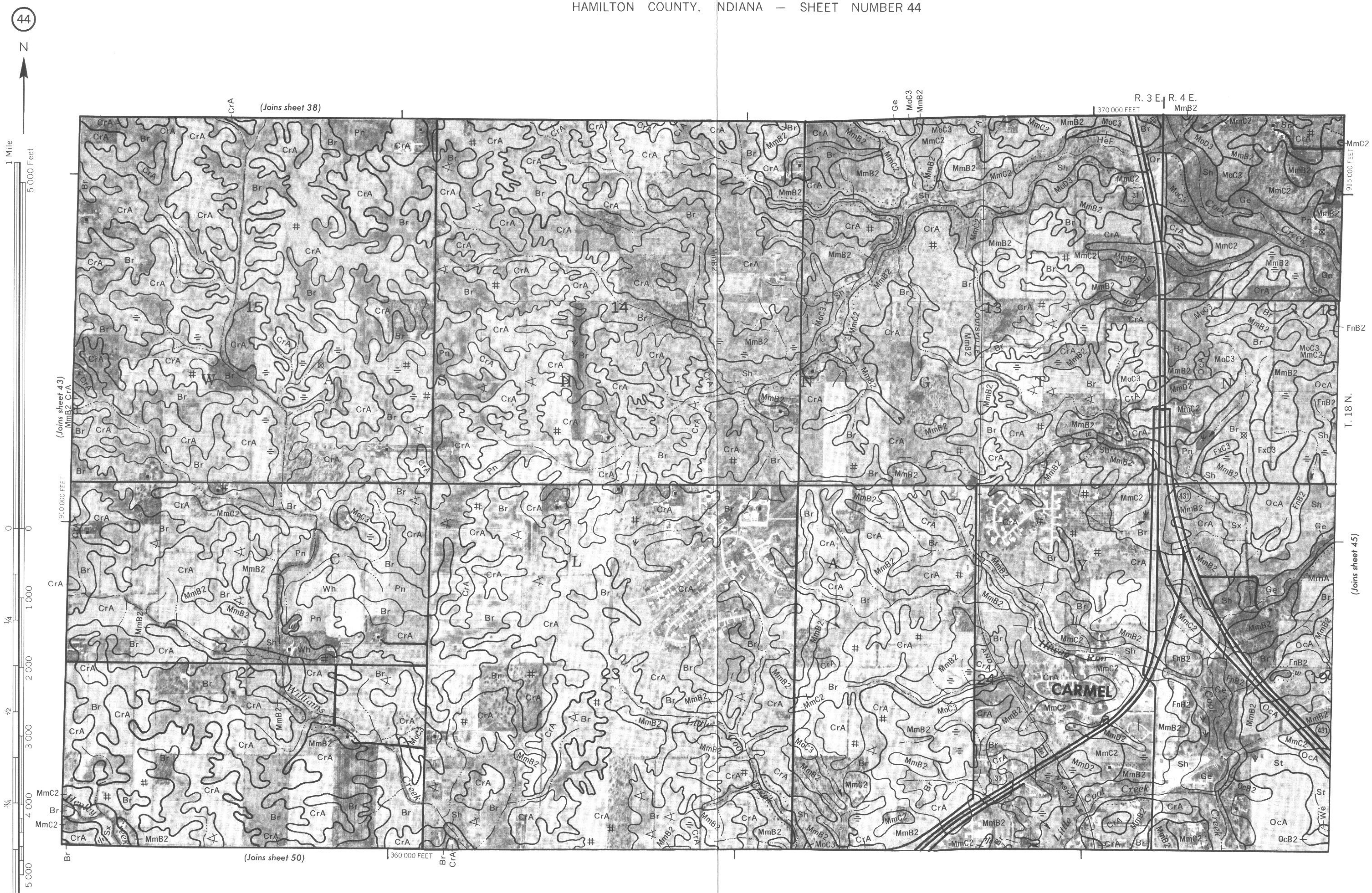
HAMILTON COUNTY, INDIANA NO. 42

HAMILTON COUNTY, INDIANA — SHEET NUMBER 43



HAMILTON COUNTY, INDIANA NO. 43

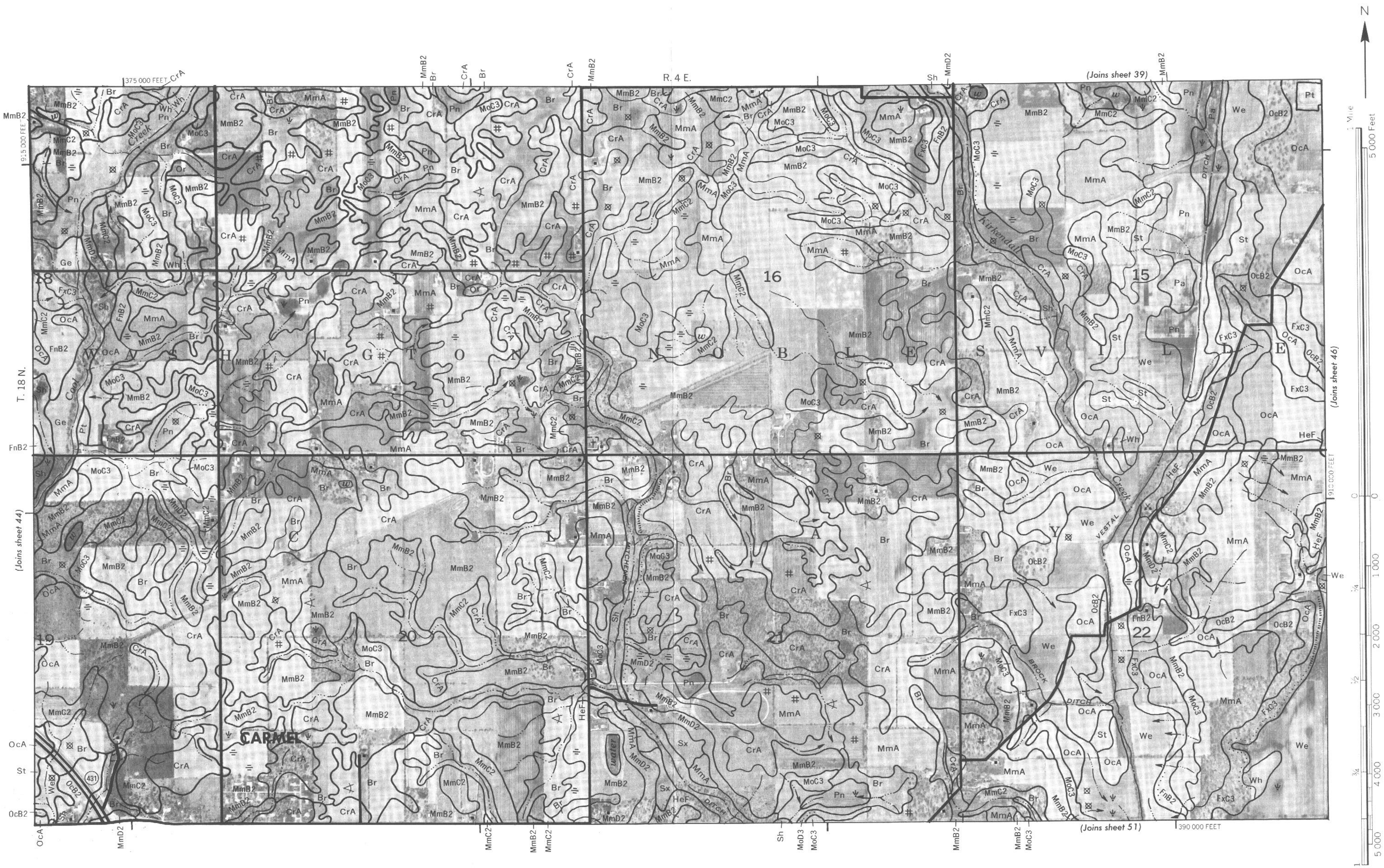
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 44

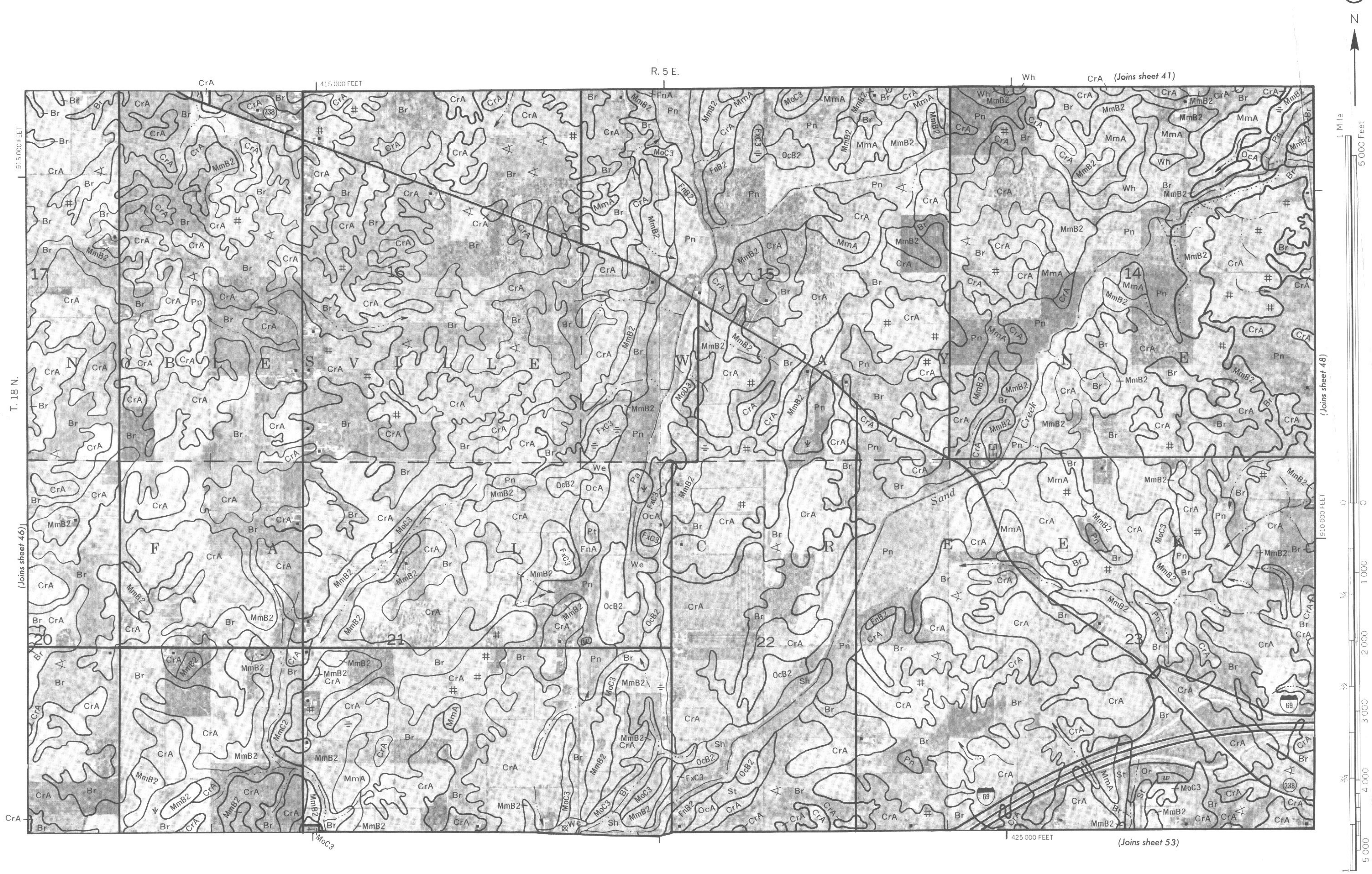
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HAMILTON COUNTY, INDIANA — SHEET NUMBER 46

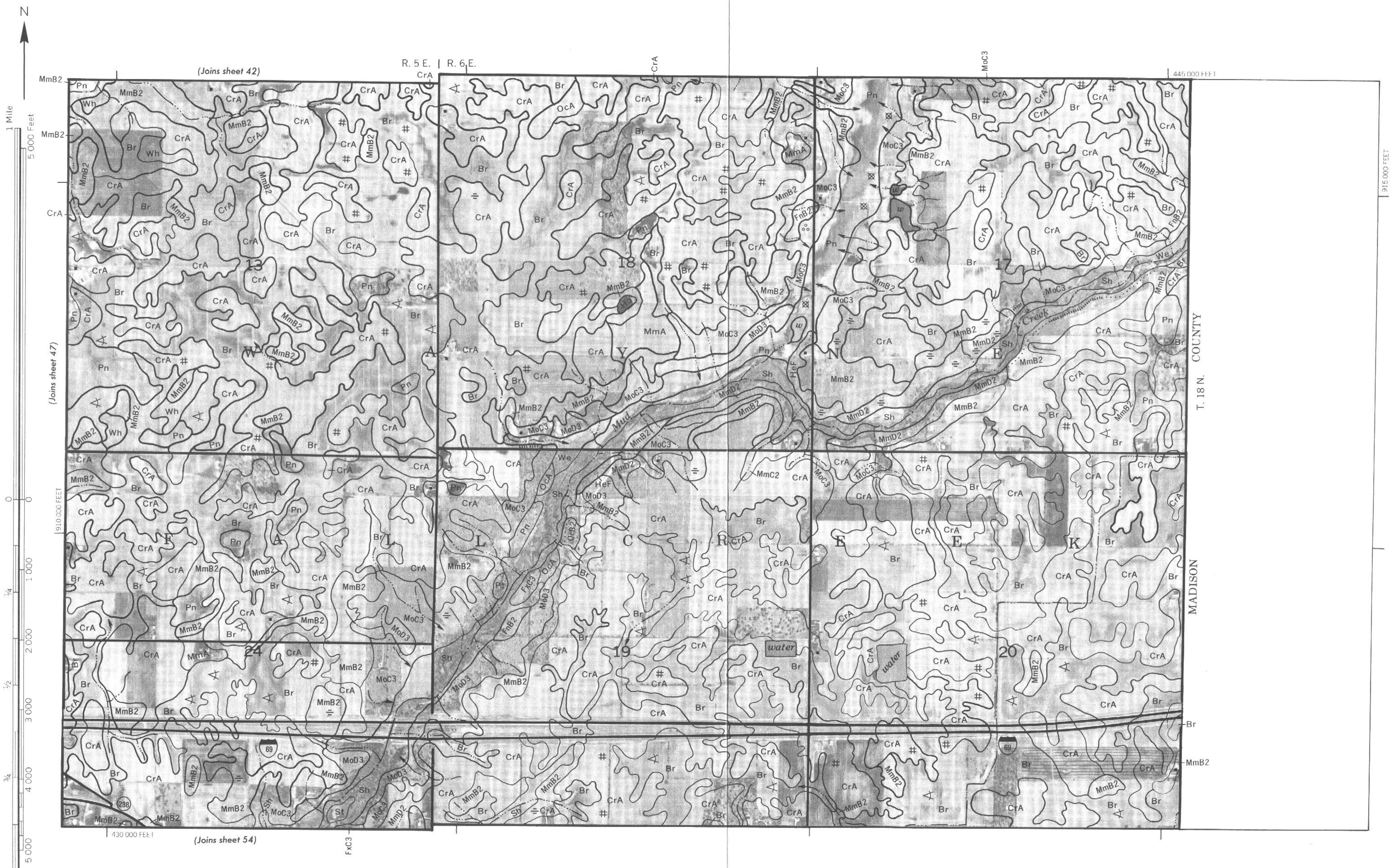
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 46



HAMILTON COUNTY, INDIANA NO. 47

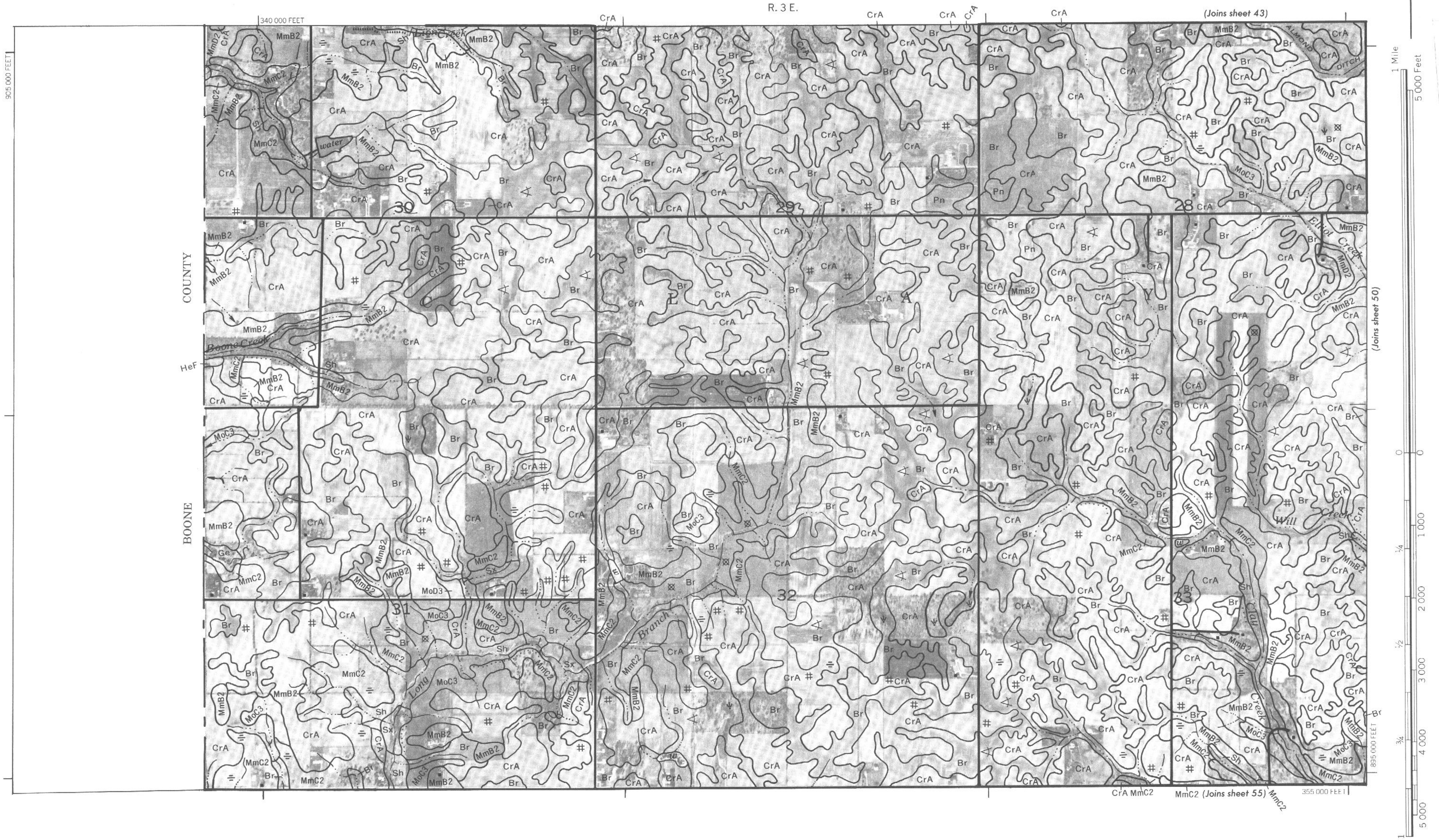
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

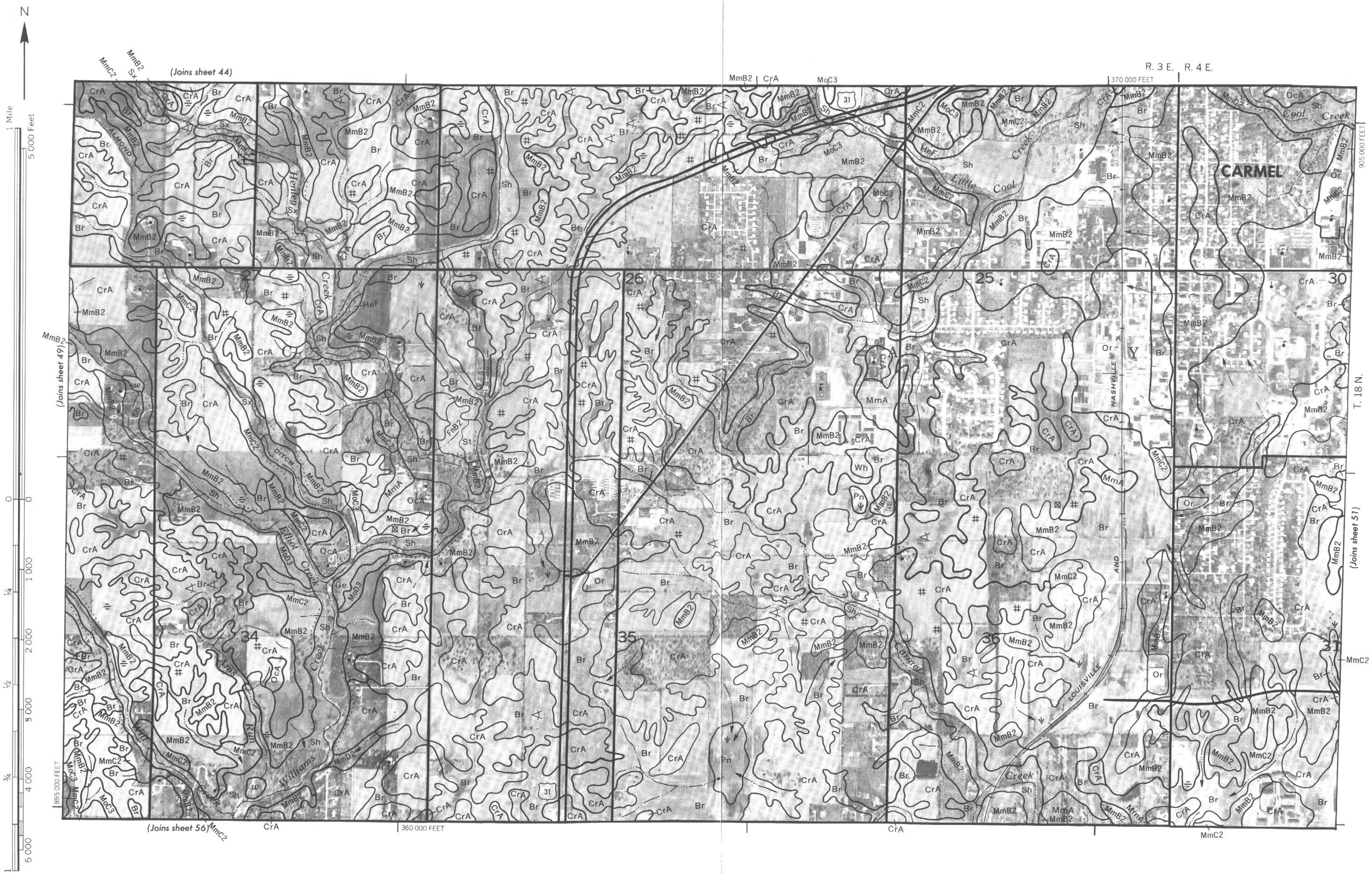


This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 49

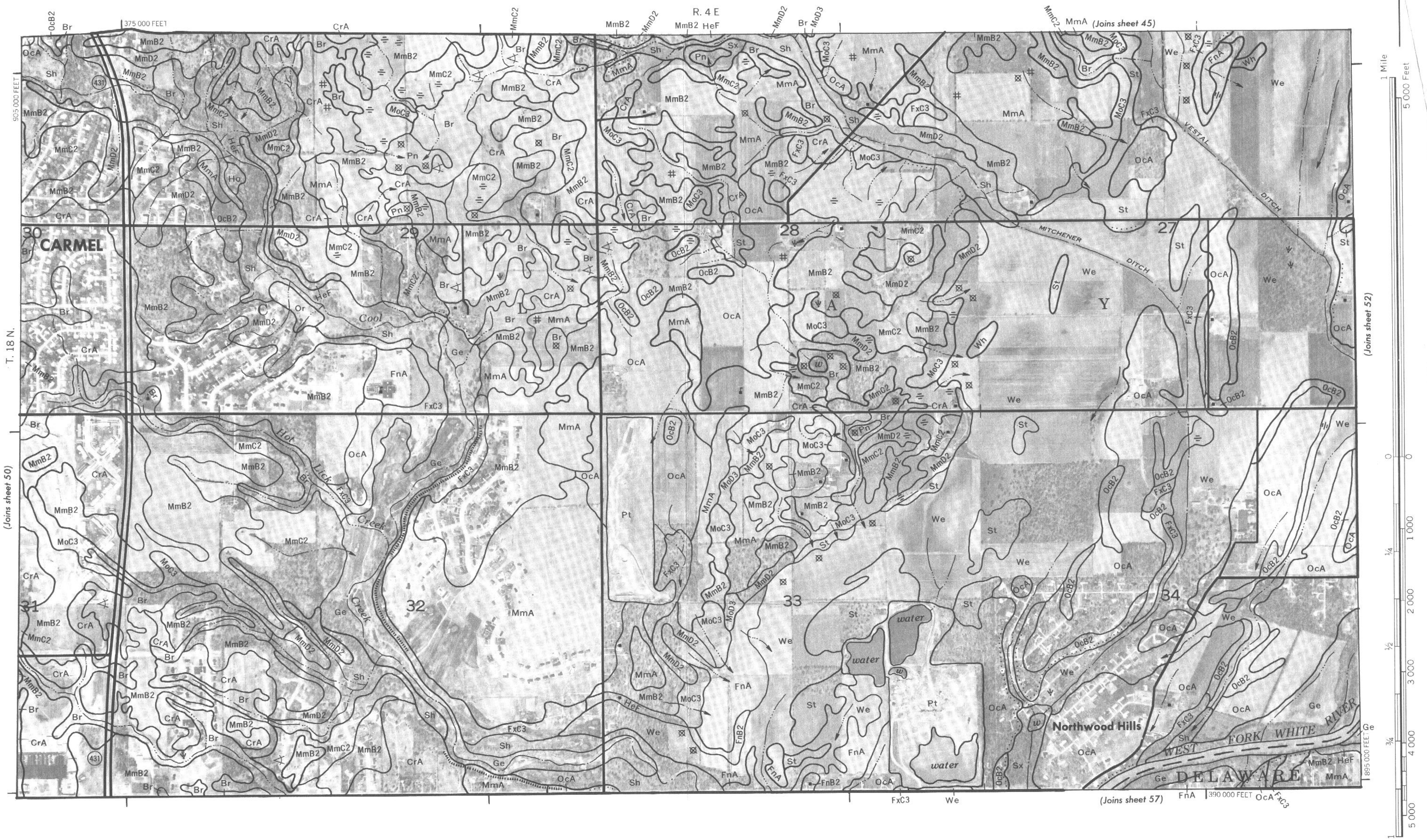
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





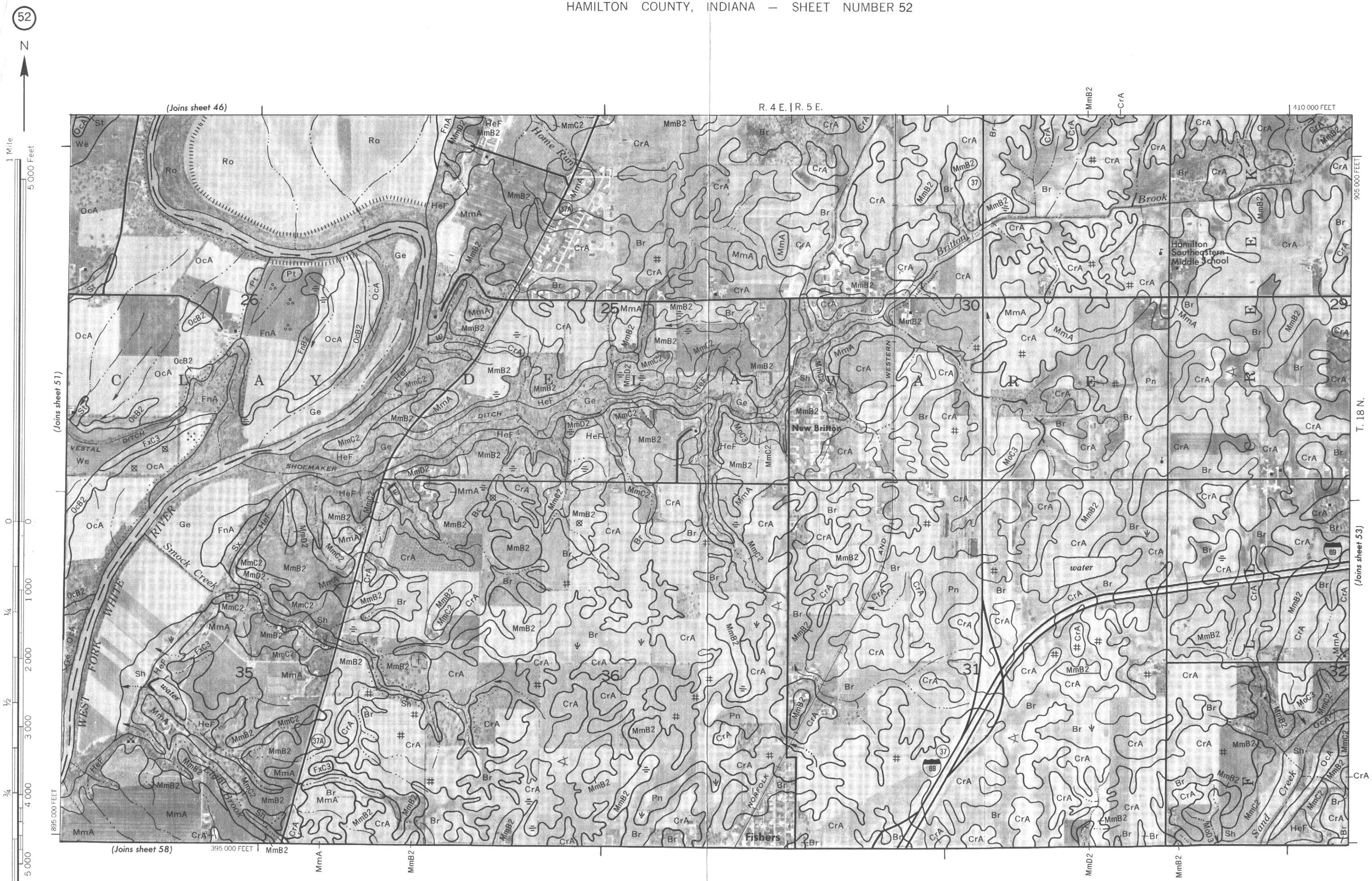
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 50



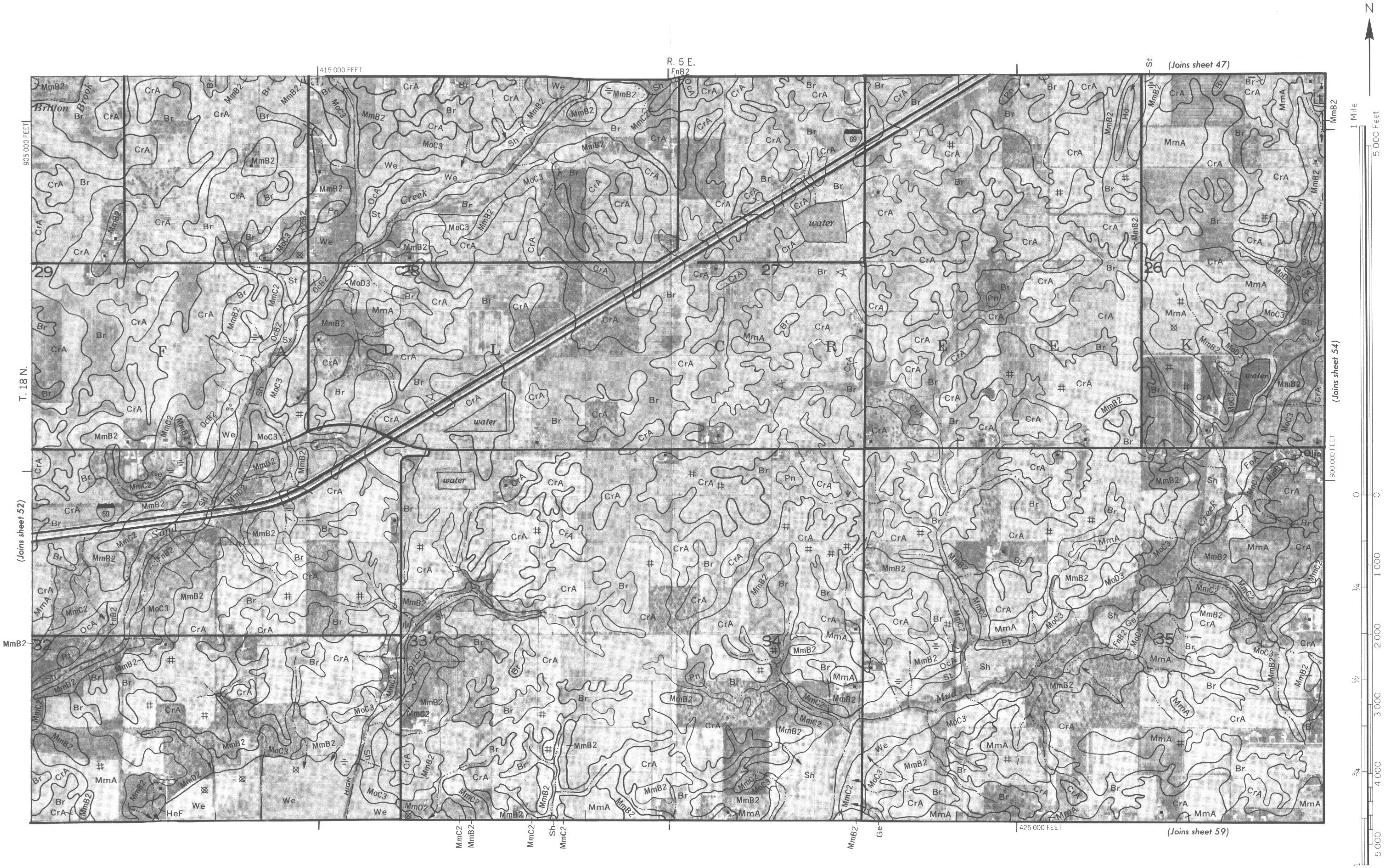
HAMILTON COUNTY, INDIANA NO. 51

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



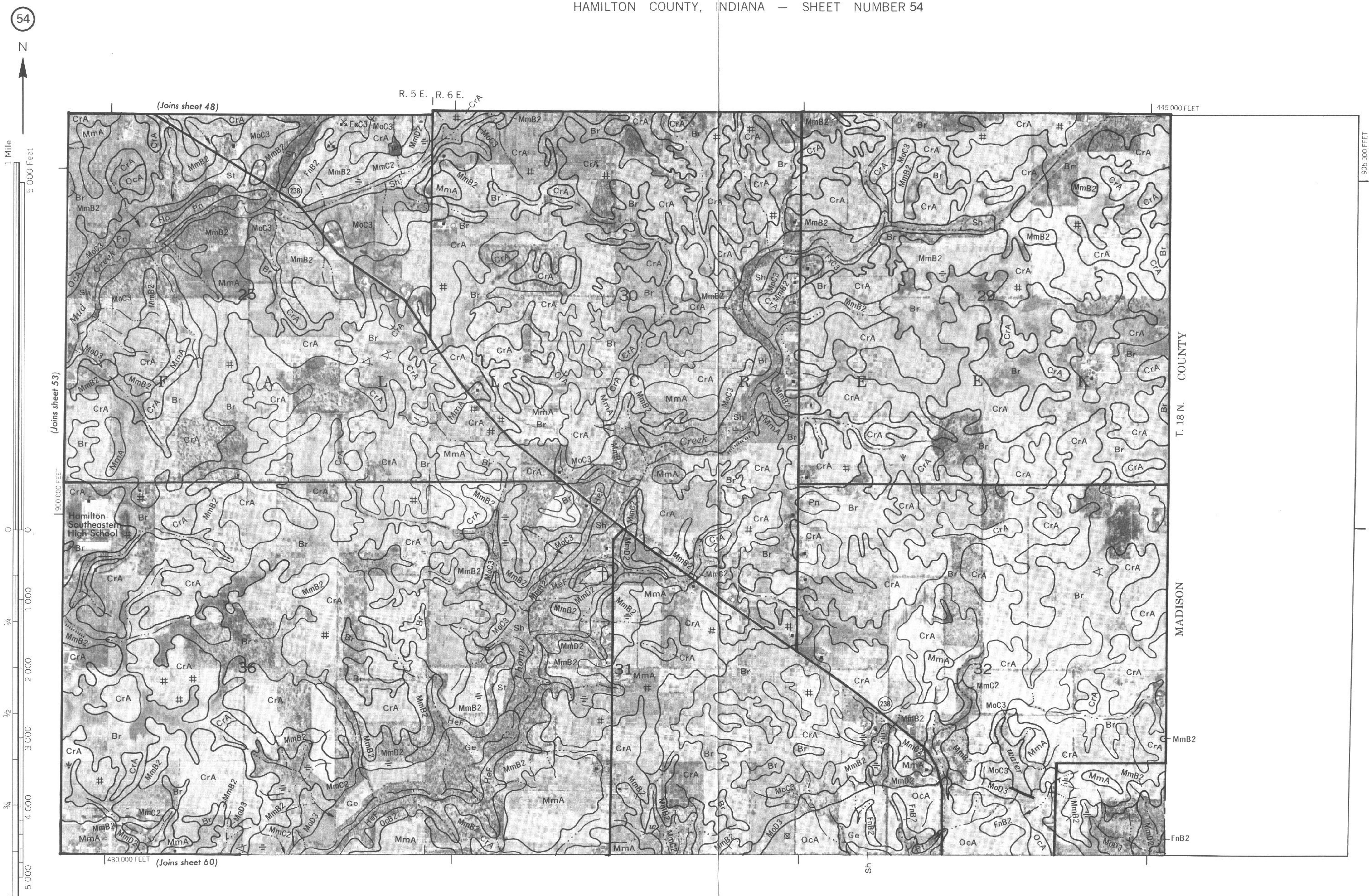
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 52



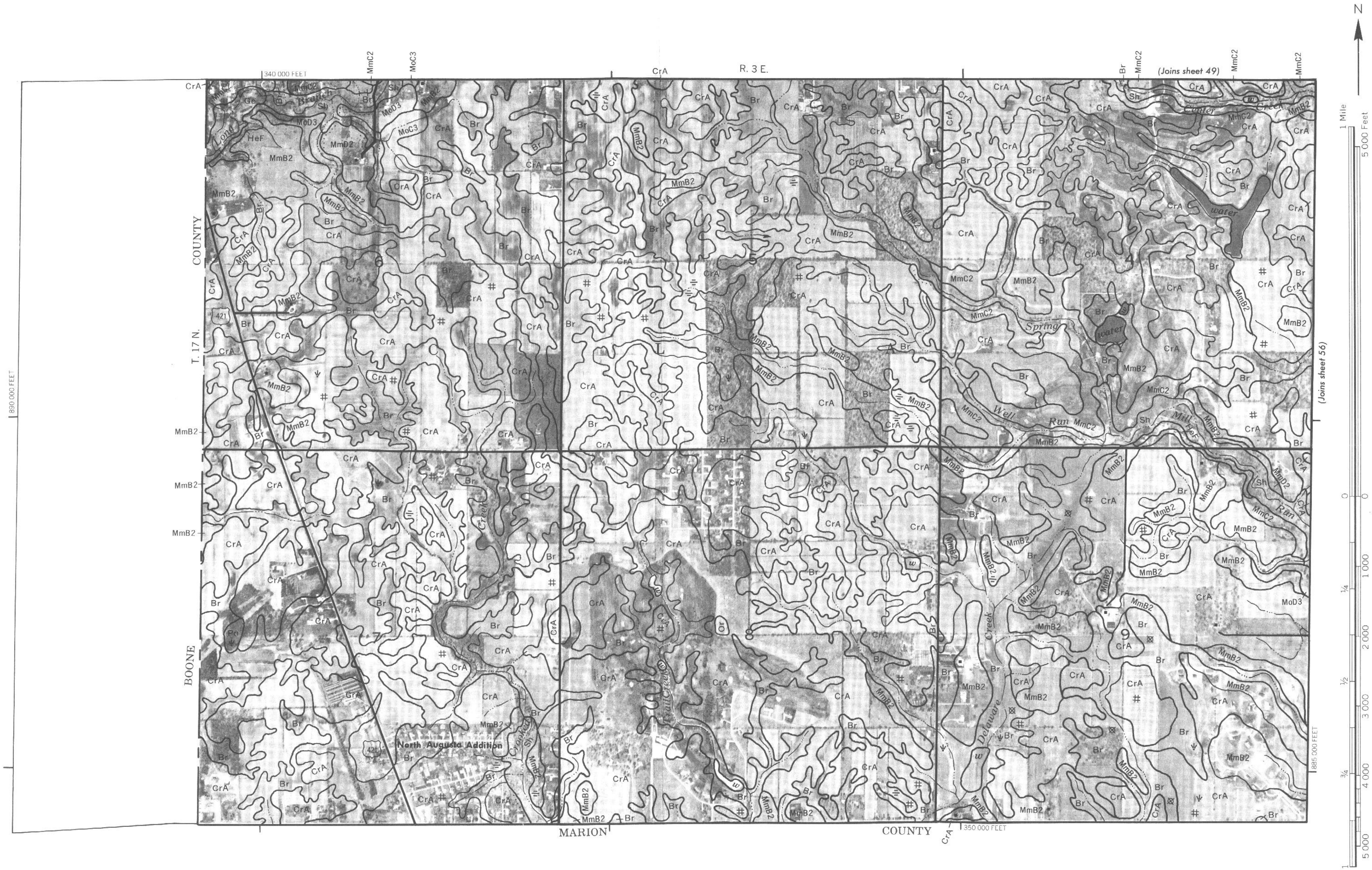
HAMILTON COUNTY, INDIANA NO. 53

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

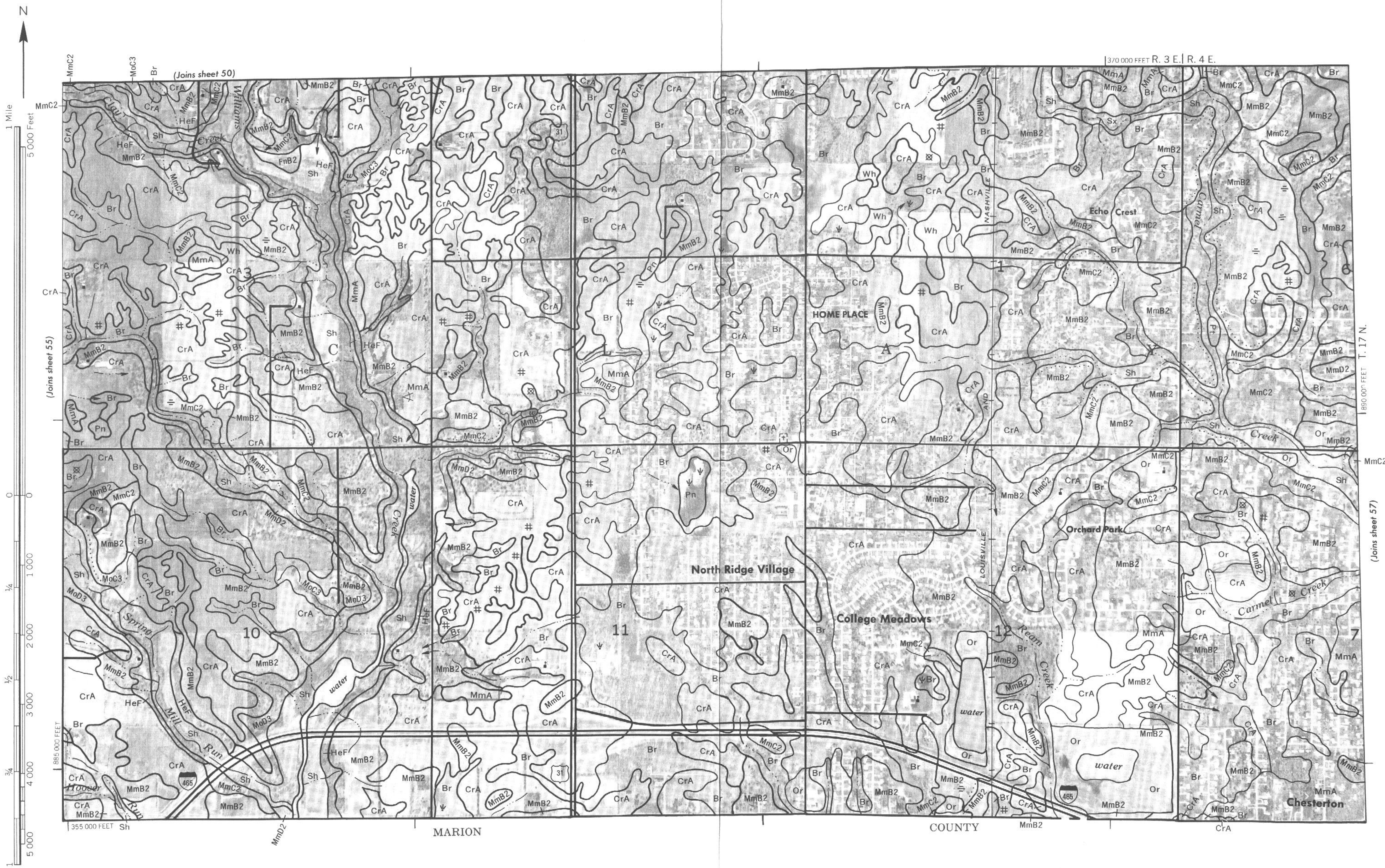
HAMILTON COUNTY, INDIANA NO. 54



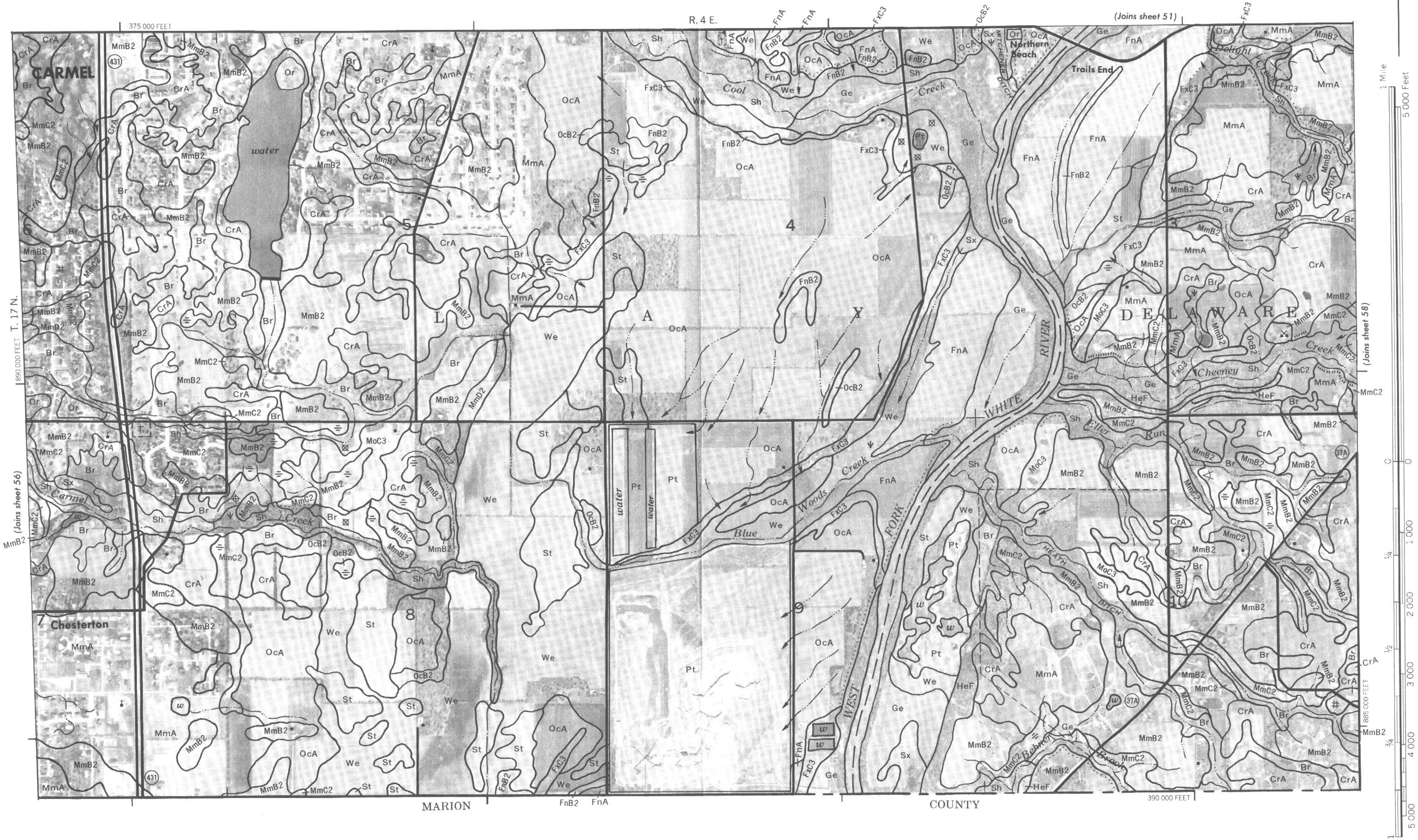
HAMILTON COUNTY, INDIANA NO. 55

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA — SHEET NUMBER 56

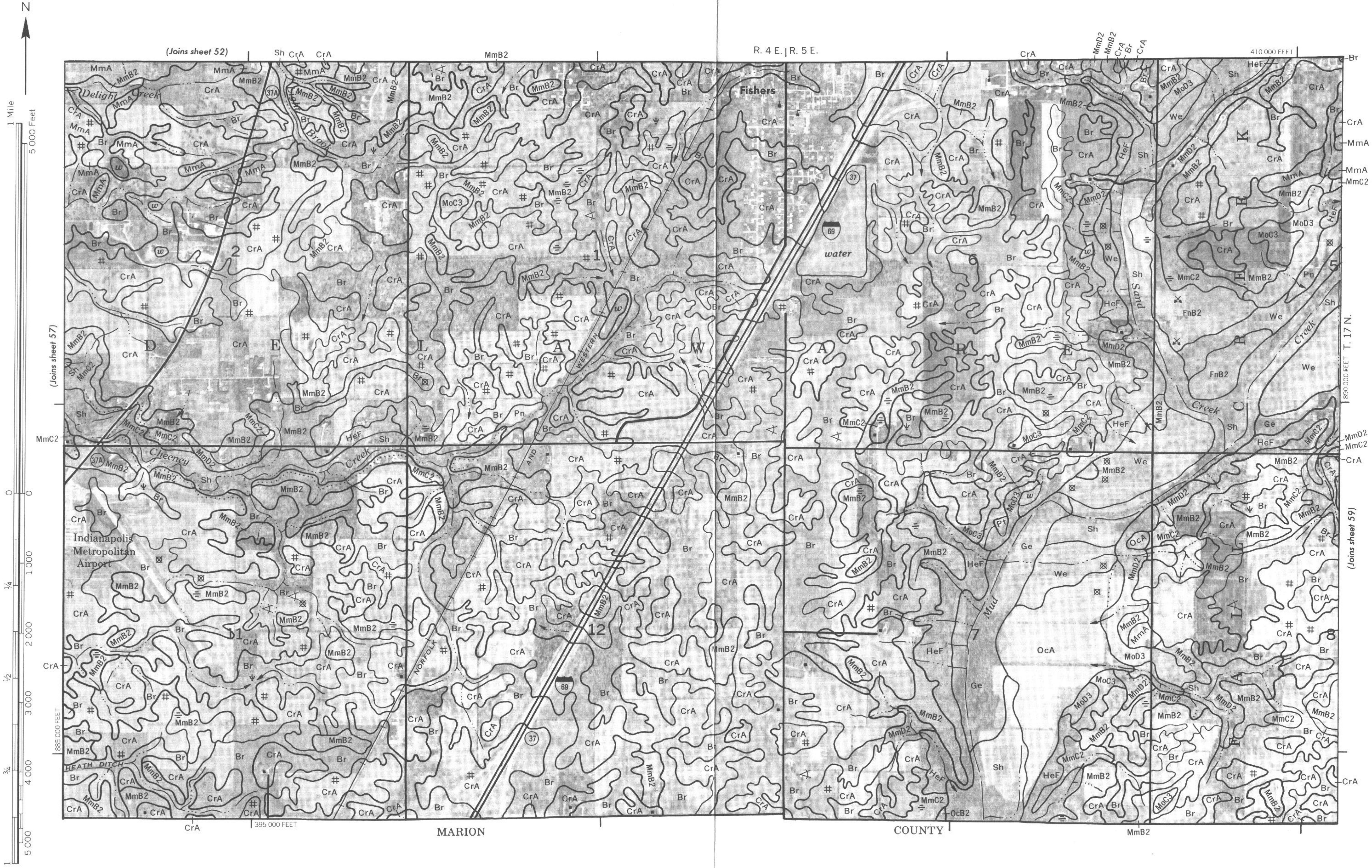


This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



HAMILTON COUNTY, INDIANA NO. 57

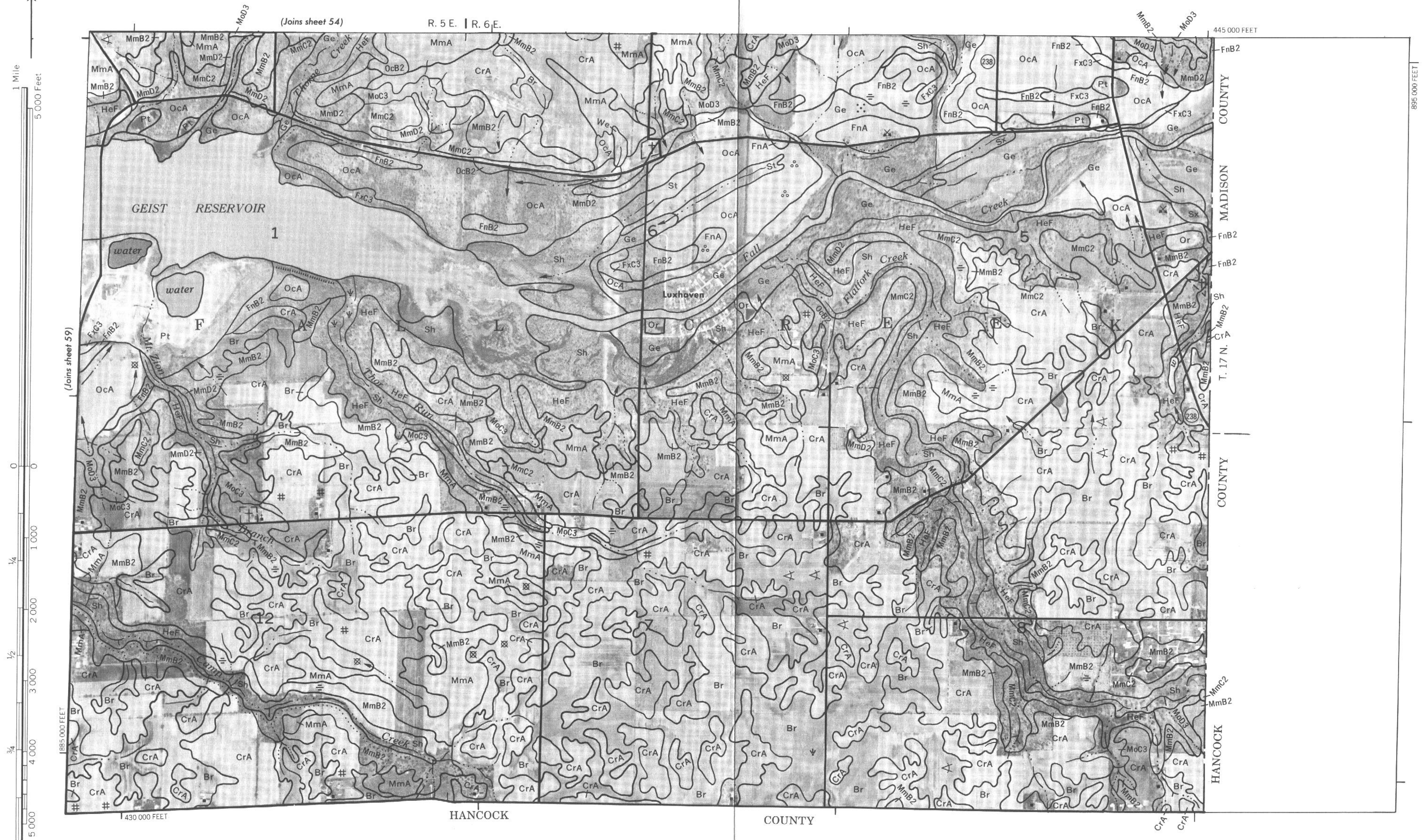
This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 59

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

HAMILTON COUNTY, INDIANA NO. 60